Shark® 200S

Electronic Submeter With WiFi Ethernet Capability & Data Logging

Installation & Operation Manual
V.1.06
February 16, 2012

Electro Industries/GaugeTech
The Leader In Power Monitoring and Smart Grid Solutions

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Shark® 200S Meter Installation and Operation Manual Version 1.06

Published by:

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1800 Shames Drive

Westbury, NY 11590

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Customer Service and Support

Customer support is available 9:00 am to 4:30 pm, Eastern Standard Time, Monday through Friday. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have all meter readings available. When returning any merchandise to EIG, a return materials authorization number is required. For customer or technical assistance, repair or calibration, phone 516-334-0870 or fax 516-338-4741.

Product Warranty

Electro Industries/GaugeTech warrants all products to be free from defects in material and workmanship for a period of four years from the date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, fax or call our customer-support department. You will receive prompt assistance and return instructions. Send the instrument, transportation prepaid, to EIG at 1800 Shames Drive, Westbury, NY 11590. Repairs will be made and the instrument will be returned.

This warranty does not apply to defects resulting from unauthorized modification, misuse, or use for any reason other than electrical power monitoring. The Shark® 200S meter is not a user-serviceable product.

OUR PRODUCTS ARE NOT TO BE USED FOR PRIMARY OVER-CURRENT PROTECTION. ANY PROTECTION FEATURE IN OUR PRODUCTS IS TO BE USED FOR ALARM OR SECONDARY PROTECTION ONLY.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ELECTRO INDUSTRIES/GAUGETECH SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING FROM ANY AUTHORIZED OR UNAUTHORIZED USE OF ANY ELECTRO INDUSTRIES/GAUGETECH PRODUCT. LIABILITY SHALL BE LIMITED TO THE ORIGINAL COST OF THE PRODUCT SOLD.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by Electro Industries/GaugeTech. The accuracy and a calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards.

Disclaimer

The information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.

This symbol indicates that the operator must refer to an explanation in the operating instructions. Please see Chapter 4 for important safety information regarding installation and hookup of the Shark® 200S meter.

FCC Information

Regarding the wireless module:

- This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) this device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.
- The antenna provided must not be replaced with an different type. Attaching a different antenna will void the FCC approval and the FCC ID can no longer be considered.

About Electro Industries/GaugeTech

Founded in 1975 by engineer and inventor Dr. Samuel Kagan, Electro Industries/GaugeTech changed the face of power monitoring forever with its first breakthrough innovation: an affordable, easy-to-use AC power meter. A few of our many technology firsts include:

- 1975: First multifunction meter
- 1981: First micro-processor based power monitor
- 1986: First PC-based power monitoring software for plant-wide power distribution analysis
- 1994: First 1 MegaByte memory high-performance power monitor for data analysis and recording
- 1999: First auto-calibrating power monitoring - Nexus® Series
- 2001: First auto-calibrating meter under glass
- 2005: Shark® 100 submeter and Shark® 100S wireless submeter with 802.11 WiFi capability
- 2007: Shark® 200 data-logging submeter with optional I/O
- 2008: First Nexus® 1500 transient recorder and power meter with advanced PQ and dual Ethernet communication ports
- 2012: EIG released many products specializing in the Smart meter and Alternative Energy marketplace.

Thirty years since its founding, Electro Industries/GaugeTech, the leader in power monitoring and control, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2000 certified company, EIG sets the industry standard for advanced power quality and reporting, revenue metering and substation data acquisition and control. EIG products can be found on site at virtually all of today's leading manufacturers, industrial giants and utilities.

All EIG products are designed, manufactured, tested and calibrated at our facility in Westbury, New York.

Applications

- Web-accessed multifunction power monitoring and control
- Single and multifunction power monitoring
- Power quality monitoring
- Onboard data logging for trending power usage and quality
- Disturbance analysis
- Revenue metering and billing
- Smart grid solutions

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1: Three-Phase Power Measurement

This introduction to three-phase power and power measurement is intended to provide only a brief overview of the subject. The professional meter engineer or meter technician should refer to more advanced documents such as the EEI Handbook for Electricity Metering and the application standards for more in-depth and technical coverage of the subject.

1.1: Three-Phase System Configurations

Three-phase power is most commonly used in situations where large amounts of power will be used because it is a more effective way to transmit the power and because it provides a smoother delivery of power to the end load. There are two commonly used connections for three-phase power, a wye connection or a delta connection. Each connection has several different manifestations in actual use.

When attempting to determine the type of connection in use, it is a good practice to follow the circuit back to the transformer that is serving the circuit. It is often not possible to conclusively determine the correct circuit connection simply by counting the wires in the service or checking voltages. Checking the transformer connection will provide conclusive evidence of the circuit connection and the relationships between the phase voltages and ground.

1.1.1: Wye Connection

The wye connection is so called because when you look at the phase relationships and the winding relationships between the phases it looks like a Y. Figure 1.1 depicts the winding relationships for a wye-connected service. In a wye service the neutral (or center point of the wye) is typically grounded. This leads to common voltages of 208/120 and 480/277 (where the first number represents the phase-to-phase voltage and the second number represents the phase-to-ground voltage).

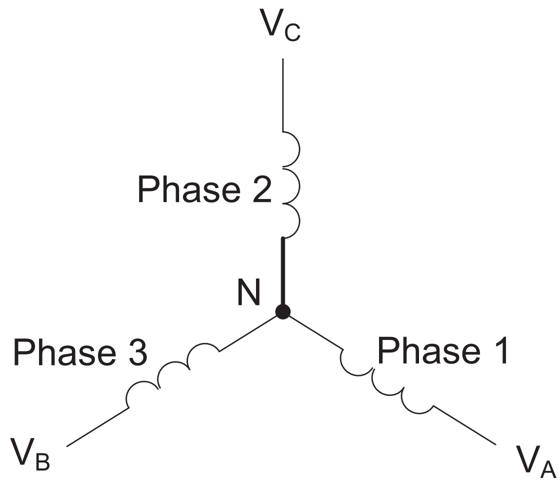


Figure 1.1: Three-phase Wye Winding

The three voltages are separated by 120° electrically. Under balanced load conditions the currents are also separated by 120°. However, unbalanced loads and other conditions can cause the currents to depart from the ideal 120°separation. Three-phase voltages and currents are usually represented with a phasor diagram. A phasor diagram for the typical connected voltages and currents is shown in Figure 1.2.

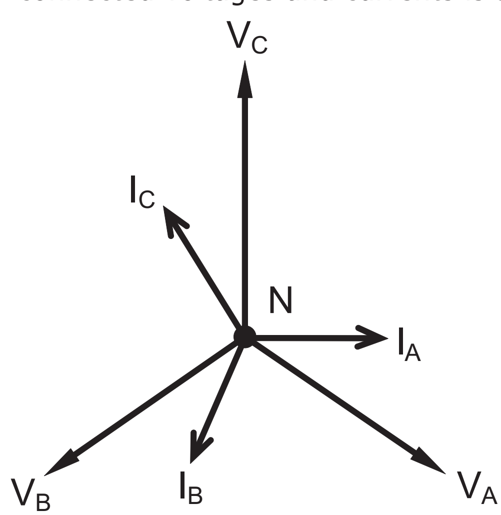


Figure 1.2: Phasor Diagram Showing Three-phase Voltages and Currents

The phasor diagram shows the 120^{o} angular separation between the phase voltages. The phase-to-phase voltage in a balanced three-phase wye system is 1.732 times the phase-to-neutral voltage. The center point of the wye is tied together and is typically grounded. Table 1.1 shows the common voltages used in the United States for wye-connected systems.

Phase to Ground Voltage	**Phase to Phase Voltage**
120 volts	208 volts
277 volts	480 volts
2,400 volts	4,160 volts
7,200 volts	12,470 volts
7,620 volts	13,200 volts

Table 1: Common Phase Voltages on Wye Services

Usually a wye-connected service will have four wires: three wires for the phases and one for the neutral. The three-phase wires connect to the three phases (as shown in Figure 1.1). The neutral wire is typically tied to the ground or center point of the wye.

In many industrial applications the facility will be fed with a four-wire wye service but only three wires will be run to individual loads. The load is then often referred to as a delta-connected load but the service to the facility is still a wye service; it contains four wires if you trace the circuit back to its source (usually a transformer). In this type of connection the phase to ground voltage will be the phase-to-ground voltage indicated in Table 1, even though a neutral or ground wire is not physically present at the load. The transformer is the best place to determine the circuit connection type because this is a location where the voltage reference to ground can be conclusively identified.

1.1.2: Delta Connection

Delta-connected services may be fed with either three wires or four wires. In a three-phase delta service the load windings are connected from phase-to-phase rather than from phase-to-ground. Figure 1.3 shows the physical load connections for a delta service.

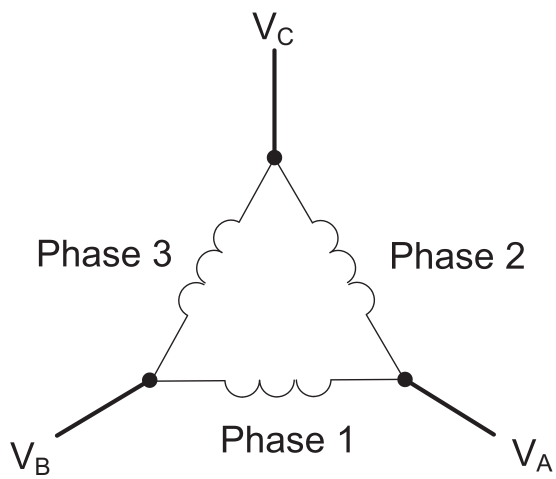


Figure 1.3: Three-phase Delta Winding Relationship

In this example of a delta service, three wires will transmit the power to the load. In a true delta service, the phase-to-ground voltage will usually not be balanced because the ground is not at the center of the delta.

Figure 1.4 shows the phasor relationships between voltage and current on a three-phase delta circuit.

In many delta services, one corner of the delta is grounded. This means the phase to ground voltage will be zero for one phase and will be full phase-to-phase voltage for the other two phases. This is done for protective purposes.

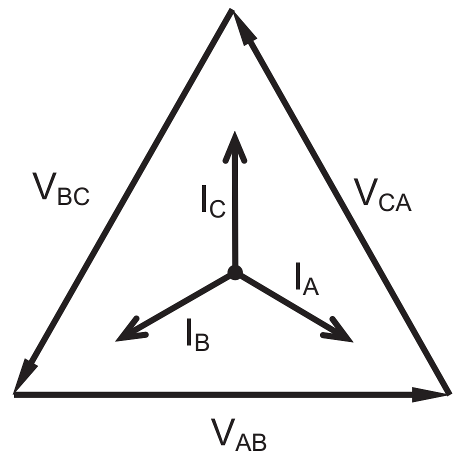


Figure 1.4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

Another common delta connection is the four-wire, grounded delta used for lighting loads. In this connection the center point of one winding is grounded. On a 120/240 volt, four-wire, grounded delta service the phase-to-ground voltage would be 120 volts on two phases and 208 volts on the third phase. Figure 1.5 shows the phasor diagram for the voltages in a three-phase, four-wire delta system.

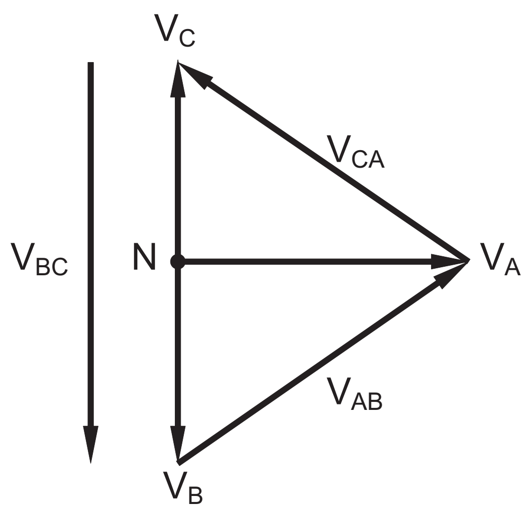


Figure 1.5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

1.1.3: Blondell's Theorem and Three Phase Measurement

In 1893 an engineer and mathematician named Andre E. Blondell set forth the first scientific basis for polyphase metering. His theorem states:

If energy is supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of the readings of N wattmeters so arranged that each of the N wires contains one current coil, the corresponding potential coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 Wattmeters.

The theorem may be stated more simply, in modern language:

In a system of N conductors, N-1 meter elements will measure the power or energy taken provided that all the potential coils have a common tie to the conductor in which there is no current coil.

Three-phase power measurement is accomplished by measuring the three individual phases and adding them together to obtain the total three phase value. In older analog meters, this measurement was accomplished using up to three separate elements. Each element combined the single-phase voltage and current to produce a torque on the meter disk. All three elements were arranged around the disk so that the disk was subjected to the combined torque of the three elements. As a result the disk would turn at a higher speed and register power supplied by each of the three wires.

According to Blondell's Theorem, it was possible to reduce the number of elements under certain conditions. For example, a three-phase, three-wire delta system could be correctly measured with two elements (two potential coils and two current coils) if the potential coils were connected between the three phases with one phase in common.

In a three-phase, four-wire wye system it is necessary to use three elements. Three voltage coils are connected between the three phases and the common neutral conductor. A current coil is required in each of the three phases.

In modern digital meters, Blondell's Theorem is still applied to obtain proper metering. The difference in modern meters is that the digital meter measures each phase voltage and current and calculates the single-phase power for each phase. The meter then sums the three phase powers to a single three-phase reading.

Some digital meters calculate the individual phase power values one phase at a time. This means the meter samples the voltage and current on one phase and calculates a power value. Then it samples the second phase and calculates the power for the second phase. Finally, it samples the third phase and calculates that phase power. After sampling all three phases, the meter combines the three readings to create the equivalent three-phase power value. Using mathematical averaging techniques, this method can derive a quite accurate measurement of three-phase power.

More advanced meters actually sample all three phases of voltage and current simultaneously and calculate the individual phase and three-phase power values. The advantage of simultaneous sampling is the reduction of error introduced due to the difference in time when the samples were taken.

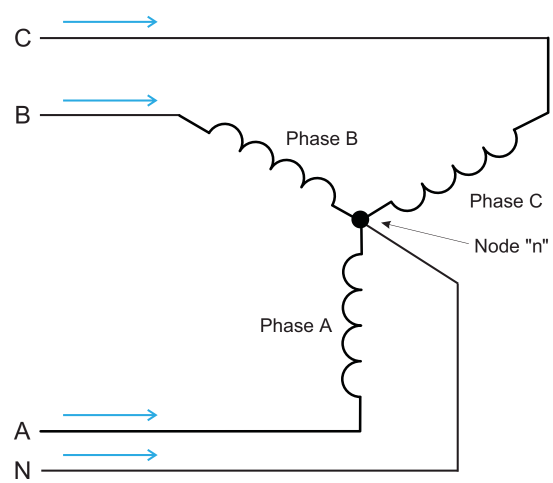


Figure 1.6: Three-Phase Wye Load Illustrating Kirchhoff’s Law and Blondell’s Theorem

Blondell's Theorem is a derivation that results from Kirchhoff's Law. Kirchhoff's Law states that the sum of the currents into a node is zero. Another way of stating the same thing is that the current into a node (connection point) must equal the current out of the node. The law can be applied to measuring three-phase loads. Figure 1.6 shows a typical connection of a three-phase load applied to a three-phase, four-wire service. Krichhoff's Law holds that the sum of currents A, B, C and N must equal zero or that the sum of currents into Node "n" must equal zero.

If we measure the currents in wires A, B and C, we then know the current in wire N by Kirchhoff's Law and it is not necessary to measure it. This fact leads us to the conclusion of Blondell's Theorem- that we only need to measure the power in three of

the four wires if they are connected by a common node. In the circuit of Figure 1.6 we must measure the power flow in three wires. This will require three voltage coils and three current coils (a three-element meter). Similar figures and conclusions could be reached for other circuit configurations involving Delta-connected loads.

1.2: Power, Energy and Demand

It is quite common to exchange power, energy and demand without differentiating between the three. Because this practice can lead to confusion, the differences between these three measurements will be discussed.

Power is an instantaneous reading. The power reading provided by a meter is the present flow of watts. Power is measured immediately just like current. In many digital meters, the power value is actually measured and calculated over a one second interval because it takes some amount of time to calculate the RMS values of voltage and current. But this time interval is kept small to preserve the instantaneous nature of power.

Energy is always based on some time increment; it is the integration of power over a defined time increment. Energy is an important value because almost all electric bills are based, in part, on the amount of energy used.

Typically, electrical energy is measured in units of kilowatt-hours (kWh). A kilowatt-hour represents a constant load of one thousand watts (one kilowatt) for one hour. Stated another way, if the power delivered (instantaneous watts) is measured as 1,000 watts and the load was served for a one hour time interval then the load would have absorbed one kilowatt-hour of energy. A different load may have a constant power requirement of 4,000 watts. If the load were served for one hour it would absorb four kWh. If the load were served for 15 minutes it would absorb ¼ of that total or one kWh.

Figure 1.7 shows a graph of power and the resulting energy that would be transmitted as a result of the illustrated power values. For this illustration, it is assumed that the power level is held constant for each minute when a measurement is taken. Each bar in the graph will represent the power load for the one-minute increment of time. In real life the power value moves almost constantly.

The data from Figure 1.7 is reproduced in Table 2 to illustrate the calculation of energy. Since the time increment of the measurement is one minute and since we

specified that the load is constant over that minute, we can convert the power reading to an equivalent consumed energy reading by multiplying the power reading times 1/60 (converting the time base from minutes to hours).

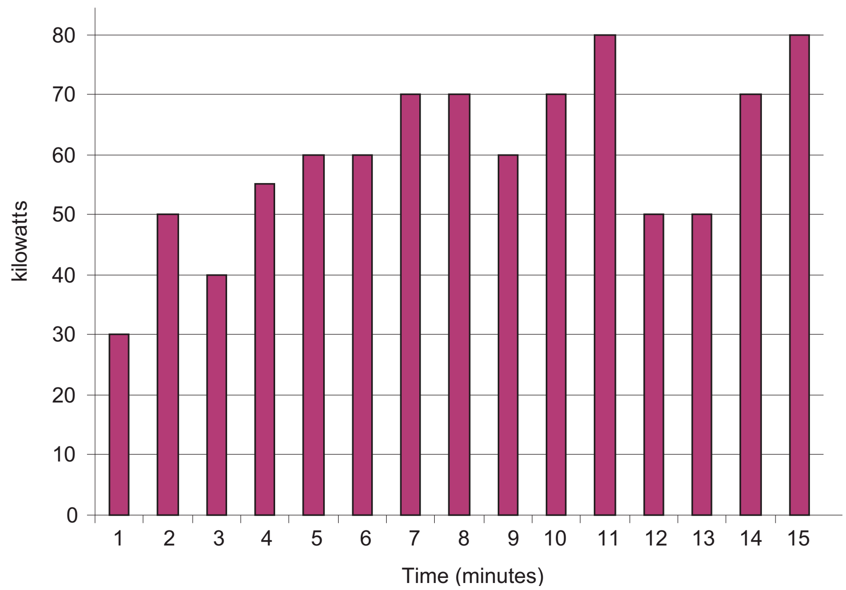


Figure 1.7: Power Use over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
1	30	0.50	0.50
2	50	0.83	1.33
3	40	0.67	2.00
4	55	0.92	2.92
5	60	1.00	3.92
6	60	1.00	4.92
7	70	1.17	6.09
8	70	1.17	7.26
9	60	1.00	8.26
10	70	1.17	9.43
11	80	1.33	10.76
12	50	0.83	12.42
13	50	0.83	12.42
14	70	1.17	13.59
15	80	1.33	14.92

Table 1.2: Power and Energy Relationship over Time

As in Table 1.2, the accumulated energy for the power load profile of Figure 1.7 is 14.92 kWh.

Demand is also a time-based value. The demand is the average rate of energy use over time. The actual label for demand is kilowatt-hours/hour but this is normally reduced to kilowatts. This makes it easy to confuse demand with power, but demand is not an instantaneous value. To calculate demand it is necessary to accumulate the energy readings (as illustrated in Figure 1.7) and adjust the energy reading to an hourly value that constitutes the demand.

In the example, the accumulated energy is 14.92 kWh. But this measurement was made over a 15-minute interval. To convert the reading to a demand value, it must be normalized to a 60-minute interval. If the pattern were repeated for an additional three 15-minute intervals the total energy would be four times the measured value or

59.68 kWh. The same process is applied to calculate the 15-minute demand value. The demand value associated with the example load is 59.68 kWh/hr or 59.68 kWd. Note that the peak instantaneous value of power is 80 kW, significantly more than the demand value.

Figure 1.8 shows another example of energy and demand. In this case, each bar represents the energy consumed in a 15-minute interval. The energy use in each interval typically falls between 50 and 70 kWh. However, during two intervals the energy rises sharply and peaks at 100 kWh in interval number 7. This peak of usage will result in setting a high demand reading. For each interval shown the demand value would be four times the indicated energy reading. So interval 1 would have an associated demand of 240 kWh/hr.   Interval 7 will have a demand value of 400 kWh/hr. In the data shown, this is the peak demand value and would be the number that would set the demand charge on the utility bill.

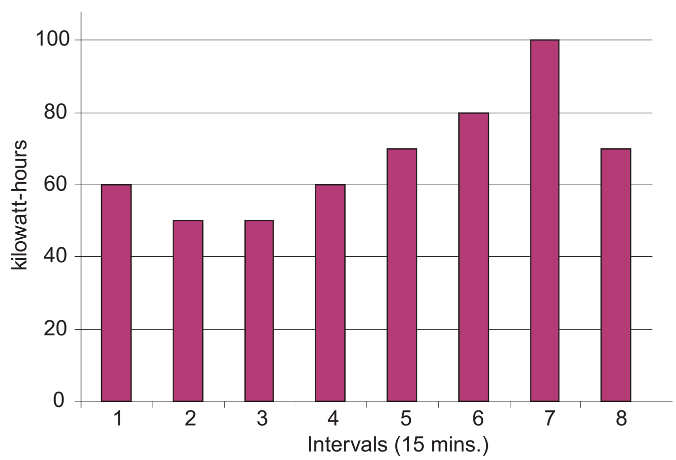


Figure 1.8: Energy Use and Demand

As can be seen from this example, it is important to recognize the relationships between power, energy and demand in order to control loads effectively or to monitor use correctly.

1.3: Reactive Energy and Power Factor

The real power and energy measurements discussed in the previous section relate to the quantities that are most used in electrical systems. But it is often not sufficient to only measure real power and energy. Reactive power is a critical component of the total power picture because almost all real-life applications have an impact on reactive power. Reactive power and power factor concepts relate to both load and generation applications. However, this discussion will be limited to analysis of reactive power and power factor as they relate to loads. To simplify the discussion, generation will not be considered.

Real power (and energy) is the component of power that is the combination of the voltage and the value of corresponding current that is directly in phase with the voltage. However, in actual practice the total current is almost never in phase with the voltage. Since the current is not in phase with the voltage, it is necessary to consider both the inphase component and the component that is at quadrature (angularly rotated 90^o or perpendicular) to the voltage. Figure 1.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

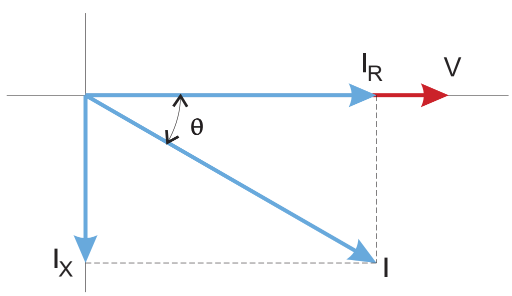


Figure 1.9: Voltage and Complex Current

The voltage (V) and the total current (I) can be combined to calculate the apparent power or VA. The voltage and the in-phase current (I_R) are combined to produce the real power or watts. The voltage and the quadrature current (I_X) are combined to calculate the reactive power.

The quadrature current may be lagging the voltage (as shown in Figure 1.9) or it may lead the voltage. When the quadrature current lags the voltage the load is requiring both real power (watts) and reactive power (VARs). When the quadrature current

leads the voltage the load is requiring real power (watts) but is delivering reactive power (VARs) back into the system; that is VARs are flowing in the opposite direction of the real power flow.

Reactive power (VARs) is required in all power systems. Any equipment that uses magnetization to operate requires VARs. Usually the magnitude of VARs is relatively low compared to the real power quantities. Utilities have an interest in maintaining VAR requirements at the customer to a low value in order to maximize the return on plant invested to deliver energy. When lines are carrying VARs, they cannot carry as many watts. So keeping the VAR content low allows a line to carry its full capacity of watts. In order to encourage customers to keep VAR requirements low, some utilities impose a penalty if the VAR content of the load rises above a specified value.

A common method of measuring reactive power requirements is power factor. Power factor can be defined in two different ways. The more common method of calculating power factor is the ratio of the real power to the apparent power. This relationship is expressed in the following formula:

Total PF = real power / apparent power = watts/VA

This formula calculates a power factor quantity known as Total Power Factor. It is called Total PF because it is based on the ratios of the power delivered. The delivered power quantities will include the impacts of any existing harmonic content. If the voltage or current includes high levels of harmonic distortion the power values will be affected. By calculating power factor from the power values, the power factor will include the impact of harmonic distortion. In many cases this is the preferred method of calculation because the entire impact of the actual voltage and current are included.

A second type of power factor is Displacement Power Factor. Displacement PF is based on the angular relationship between the voltage and current. Displacement power factor does not consider the magnitudes of voltage, current or power. It is solely based on the phase angle differences. As a result, it does not include the impact of

harmonic distortion. Displacement power factor is calculated using the following equation:

$$\text{Displacement PF} = \cos\theta$$

where θ is the angle between the voltage and the current (see Fig. 1.9).

In applications where the voltage and current are not distorted, the Total Power Factor will equal the Displacement Power Factor. But if harmonic distortion is present, the two power factors will not be equal.

1.4: Harmonic Distortion

Harmonic distortion is primarily the result of high concentrations of non-linear loads. Devices such as computer power supplies, variable speed drives and fluorescent light ballasts make current demands that do not match the sinusoidal waveform of AC electricity. As a result, the current waveform feeding these loads is periodic but not sinusoidal. Figure 1.10 shows a normal, sinusoidal current waveform. This example has no distortion.

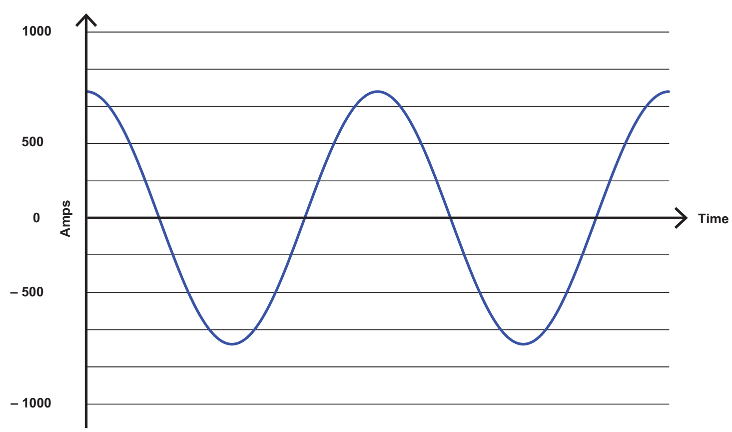


Figure 1.10: Nondistorted Current Waveform

Figure 1.11 shows a current waveform with a slight amount of harmonic distortion. The waveform is still periodic and is fluctuating at the normal 60 Hz frequency. However, the waveform is not a smooth sinusoidal form as seen in Figure 1.10.

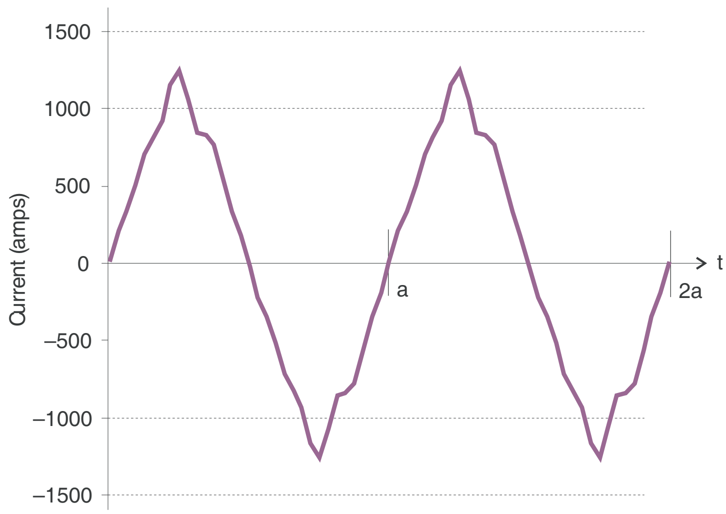


Figure 1.11: Distorted Current Waveform

The distortion observed in Figure 1.11 can be modeled as the sum of several sinusoidal waveforms of frequencies that are multiples of the fundamental 60 Hz frequency. This modeling is performed by mathematically disassembling the distorted waveform into a collection of higher frequency waveforms.

These higher frequency waveforms are referred to as harmonics. Figure 1.12 shows the content of the harmonic frequencies that make up the distortion portion of the waveform in Figure 1.11.

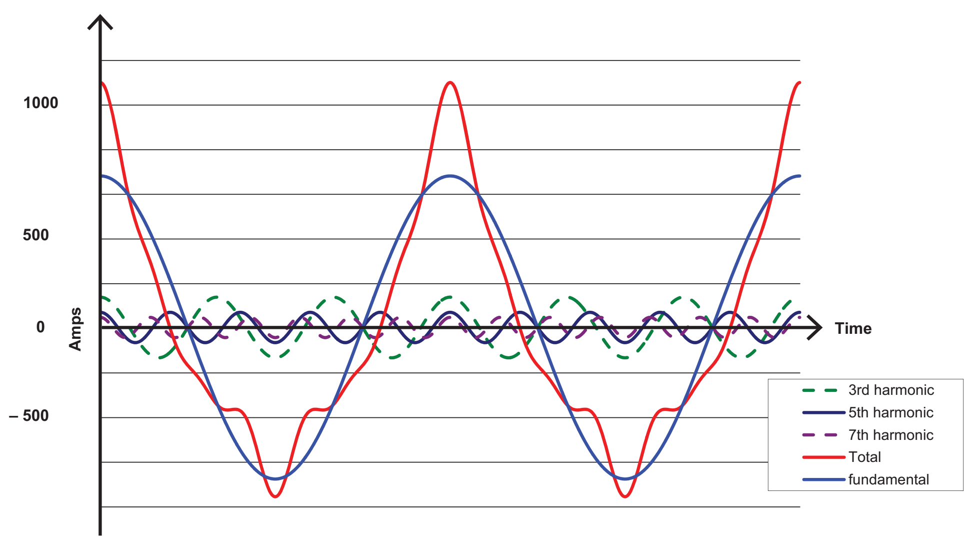


Figure 1.12: Waveforms of the Harmonics

The waveforms shown in Figure 1.12 are not smoothed but do provide an indication of the impact of combining multiple harmonic frequencies together.

When harmonics are present it is important to remember that these quantities are operating at higher frequencies. Therefore, they do not always respond in the same manner as 60 Hz values.

Inductive and capacitive impedance are present in all power systems. We are accustomed to thinking about these impedances as they perform at 60 Hz. However, these impedances are subject to frequency variation.

$X_L = j\omega L$ and

$X_C = 1/j\omega C$

At 60 Hz, ω = 377; but at 300 Hz (5th harmonic) ω = 1,885. As frequency changes impedance changes and system impedance characteristics that are normal at 60 Hz may behave entirely differently in the presence of higher order harmonic waveforms.

Traditionally, the most common harmonics have been the low order, odd frequencies, such as the 3rd, 5th, 7th, and 9th. However newer, new-linear loads are introducing significant quantities of higher order harmonics.

Since much voltage monitoring and almost all current monitoring is performed using instrument transformers, the higher order harmonics are often not visible. Instrument transformers are designed to pass 60 Hz quantities with high accuracy. These devices, when designed for accuracy at low frequency, do not pass high frequencies with high accuracy; at frequencies above about 1200 Hz they pass almost no information. So when instrument transformers are used, they effectively filter out higher frequency harmonic distortion making it impossible to see.

However, when monitors can be connected directly to the measured circuit (such as direct connection to a 480 volt bus) the user may often see higher order harmonic distortion. An important rule in any harmonics study is to evaluate the type of equipment and connections before drawing a conclusion. Not being able to see harmonic distortion is not the same as not having harmonic distortion.

It is common in advanced meters to perform a function commonly referred to as waveform capture. Waveform capture is the ability of a meter to capture a present picture of the voltage or current waveform for viewing and harmonic analysis.

Typically a waveform capture will be one or two cycles in duration and can be viewed as the actual waveform, as a spectral view of the harmonic content, or a tabular view showing the magnitude and phase shift of each harmonic value. Data collected with waveform capture is typically not saved to memory. Waveform capture is a real-time data collection event.

Waveform capture should not be confused with waveform recording that is used to record multiple cycles of all voltage and current waveforms in response to a transient condition.

1.5: Power Quality

Power quality can mean several different things. The terms "power quality" and "power quality problem" have been applied to all types of conditions. A simple definition of "power quality problem" is any voltage, current or frequency deviation that results in mis-operation or failure of customer equipment or systems. The causes of power quality problems vary widely and may originate in the customer equipment, in an adjacent customer facility or with the utility.

In his book Power Quality Primer, Barry Kennedy provided information on different types of power quality problems. Some of that information is summarized in Table 1.3.

Cause	Disturbance Type	Source
Impulse transient	Transient voltage disturbance, sub-cycle duration	Lightning Electrostatic discharge Load switching Capacitor switching
Oscillatory transient with decay	Transient voltage, sub-cycle duration	Line/cable switching Capacitor switching Load switching
Sag/swell	RMS voltage, multiple cycle duration	Remote system faults
Interruptions	RMS voltage, multiple seconds or longer duration	System protection Circuit breakers Fuses Maintenance
Under voltage/over voltage	RMS voltage, steady state, multiple seconds or longer duration	Motor starting Load variations Load dropping
Voltage flicker	RMS voltage, steady state, repetitive condition	Intermittent loads Motor starting Arc furnaces
Harmonic distortion	Steady state current or voltage, long-term duration	Non-linear loads System resonance

Table 1.3: Typical Power Quality Problems and Sources

It is often assumed that power quality problems originate with the utility. While it is true that may power quality problems can originate with the utility system, many problems originate with customer equipment. Customer-caused problems may manifest themselves inside the customer location or they may be transported by the utility system to another adjacent customer. Often, equipment that is sensitive to power quality problems may in fact also be the cause of the problem.

If a power quality problem is suspected, it is generally wise to consult a power quality professional for assistance in defining the cause and possible solutions to the problem.

2: Shark® 200S Submeter Overview and Specifications

2.1: Hardware Overview

The Shark® 200S multifunction submeter is designed to measure revenue grade electrical energy usage and communicate that information via various communication media. The unit supports RS485, RJ45 wired Ethernet or IEEE 802.11 WiFi Ethernet connections. This allows the Shark® 200S submeter to be placed anywhere within an industrial or commercial facility and still communicate quickly and easily back to central software. The unit also has a front IrDA port that can be read and configured with an IrDA-equipped device, such as a laptop PC.

The unit is designed with advanced measurement capabilities, allowing it to achieve high performance accuracy. The Shark® 200S meter is specified as a 0.2% class energy meter (Current class 10 only) for billing applications. To verify the submeter's performance and calibration, power providers use field test standards to verify that the unit's energy measurements are correct. The Shark® 200S meter is a traceable revenue meter and contains a utility grade test pulse to verify rated accuracy.

The Shark® 200S meter has up to 2 MegaBytes* for datalogging. It offers three historical logs, a Limits (Alarm) log, and a System Events log.
***NOTE**: Because the memory is flash-based rather than NVRAM (non-volatile random-access memory), some sectors are reserved for overhead, erase procedures, and spare sectors for long-term wear reduction.

Shark® 200S meter features detailed in this manual are:

- 0.2% Class Revenue Certifiable Energy and Demand Submeter (Current Class 10 only)
- Meets ANSI C12.20 (0.2%) and IEC 62053-22 (0.2%) Classes

- Multifunction Measurement including Voltage, Current, Power, Frequency, Energy, etc.
- Three line 0.56” bright red LED display
- 2 MegaBytes Memory for Datalogging
- Real Time Clock for Time-Stamping of Logs
- Percentage of Load Bar for Analog Meter Perception
- Modbus RTU (over Serial) and Modbus TCP (over Ethernet)
- Serial RS485 Communication
- Ethernet and Wireless Ethernet (WiFi)
- Easy to Use Faceplate Programming
- IrDA Port for Laptop PC Remote Read
- Direct Interface with Most Building Management Systems

The Shark® 200S submeter uses standard 5 or 1 Amp CTs (either split or donut). It surface mounts to any wall and is easily programmed in minutes. The unit is designed specifically for easy installation and advanced communication.

2.1.1: Model Number plus Option Numbers

Model	Frequency	Current Class	V-Switch™ Pack	Power Supply	Communication Format
Shark® 200S Submeter	-50 50 Hz System	-10 5 Amp Second-ary	-V33 Multifunction Meter with 2 MegaBytes Data-logging memory	-D2 (90-400) VAC (100-370)VDC	-485 RS485
	-60 60 Hz System	-2 1 Amp Second-ary			-WIFI Wireless and LAN Based (Also configurable for RS485)

Example:

Shark 200S - 60 - 10 - V33 - D2 - 485

which translates to a Shark® 200S submeter with a 60Hz system, Current class 10, Default V-Switch™, D2 power supply, and RS485 communication.

2.1.2: Measured Values

The Shark® 200S meter provides the following measured values all in real time and some additionally as average, maximum and minimum values.

Shark® 200S Meter Measured Values				
Measured Values	**Real Time**	**Average**	**Maximum**	**Minimum**
Voltage L-N	X		X	X
Voltage L-L	X		X	X
Current per Phase	X	X	X	X
Current Neutral	X	X		
Watts	X	X	X	X
VAR	X	X	X	X
VA	X	X	X	X
PF	X	X	X	X
+Watt-hr	X			

Shark® 200S Meter Measured Values				
Measured Values	**Real Time**	**Average**	**Maximum**	**Minimum**
-Watt-hr	X			
Watt-hr Net	X			
+VAR-hr	X			
-VAR-hr	X			
VAR-hr Net	X			
VA-hr	X			
Frequency	X		X	X
Voltage Angles	X			
Current Angles	X			
% of Load Bar	X			

2.1.3: Utility Peak Demand

The Shark® 200S meter provides user-configured Block (Fixed) window or Rolling window Demand. This feature allows you to set up a customized Demand profile. Block window Demand is Demand used over a user-configured Demand period (usually 5, 15 or 30 minutes). Rolling window Demand is a fixed window Demand that moves for a user-specified subinterval period.

For example, a 15-minute Demand using 3 subintervals and providing a new Demand reading every 5 minutes, based on the last 15 minutes.

Utility Demand features can be used to calculate kW, kVAR, kVA and PF readings. All other parameters offer Max and Min capability over the user-selectable averaging period. Voltage provides an Instantaneous Max and Min reading which displays the highest surge and lowest sag seen by the meter

2.2: Specifications

Power Supply

Range:	Universal, (90 to 400)VAC @50/60Hz or (100 to 370)VDC
Power Consumption:	16 VA Maximum

Voltage Inputs (Measurement Category III)

Range:	Universal, Auto-ranging up to 576VAC L-N, 721VAC L-L
Supported hookups:	3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 Wire Delta
Input Impedance:	1M Ohm/Phase
Burden:	0.36VA/Phase Max at 600V, 0.0144VA/Phase at 120V
Pickup Voltage:	10VAC
Connection:	Screw terminal - #6 - 32 screws See Figure 4.1

Input Wire Gauge:	AWG#16 - 26
Fault Withstand:	Meets IEEE C37.90.1 (Surge Withstand Capability)
Reading:	Programmable Full Scale to any PT Ratio

Current Inputs

Class 10:	5A Nominal, 10 Amp Maximum
Class 2:	1A Nominal, 2 Amp Secondary
Burden:	0.005VA Per Phase Max at 11 Amps
Pickup Current:	0.1% of Nominal
Connections:	Screw terminal - #6-32 screws (Diagram 4.1)
Current Surge Withstand:	100A/10 seconds at 23^{o} C
Reading:	Programmable Full Scale to any CT Ratio

Isolation

All Inputs and Outputs are galvanically isolated and tested to 2500VAC

Environmental Rating

Storage:	(-20 to +70)^{o} C
Operating:	(-20 to +70)^{o} C
Humidity:	to 95% RH Non-condensing
Faceplate Rating:	NEMA12 (Water Resistant)

Measurement Methods

Voltage, Current:	True RMS
Power:	Sampling at 400+ Samples per Cycle on All Channels Measured Readings Simultaneously
A/D Conversion:	6 Simultaneous 24 bit Analog to Digital Converters

Update Rate

Watts, VAR and VA:	Every 6 cycles, e.g., 100 milliseconds (Ten times per second) @60Hz
All other parameters:	Every 60 cycles, e.g, 1 second @60Hz

Communication Format

1. RS485

2. IrDA Port through Face Plate

Protocols:	Modbus RTU, Modbus ASCII, DNP 3.0, Modbus TCP (for Ethernet-enabled)
Com Port Baud Rate:	9600 to 57600 b/s
Com Port Address:	001-247
Data Format:	8 Bit, No Parity

Wireless Ethernet (Optional)

802.11b Wireless or 10/100BaseT Ethernet	WiFi or RJ45 Connection
128 bit WEP Encryption	128 bit Wireless Security

Modbus TCP Protocol

Mechanical Parameters

Dimensions:	(H7.9 x W7.6 x D3.2) inches, (H200.7 x W193.0 x D81.3) mm
Weight:	4 pounds

KYZ / RS485 Port Specifications

RS485 Transceiver; meets or exceeds EIA/TIA-485 Standard:

Type:	Two-wire, half duplex
Min. Input Impedance:	96kΩ
Max. Output Current:	±60mA

Wh Pulse

KYZ output contacts (and infrared LED light pulses through face plate): (See Section 7.4 for Kh values.)

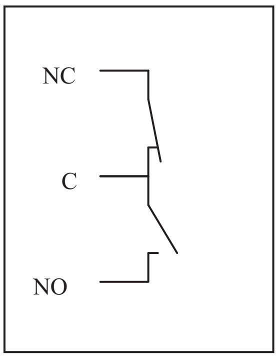
Pulse Width:	90ms
Full Scale Frequency:	~3Hz
Contact type:	Solid State – SPDT (NO – C – NC)
Relay type:	Solid state
Peak switching voltage:	DC ±350V
Continuous load current:	120mA
Peak load current:	350mA for 10ms
On resistance, max.:	35Ω
Leakage current:	1μA@350V
Isolation:	AC 3750V
Reset State:	(NC - C) Closed; (NO - C) Open

Infrared LED:

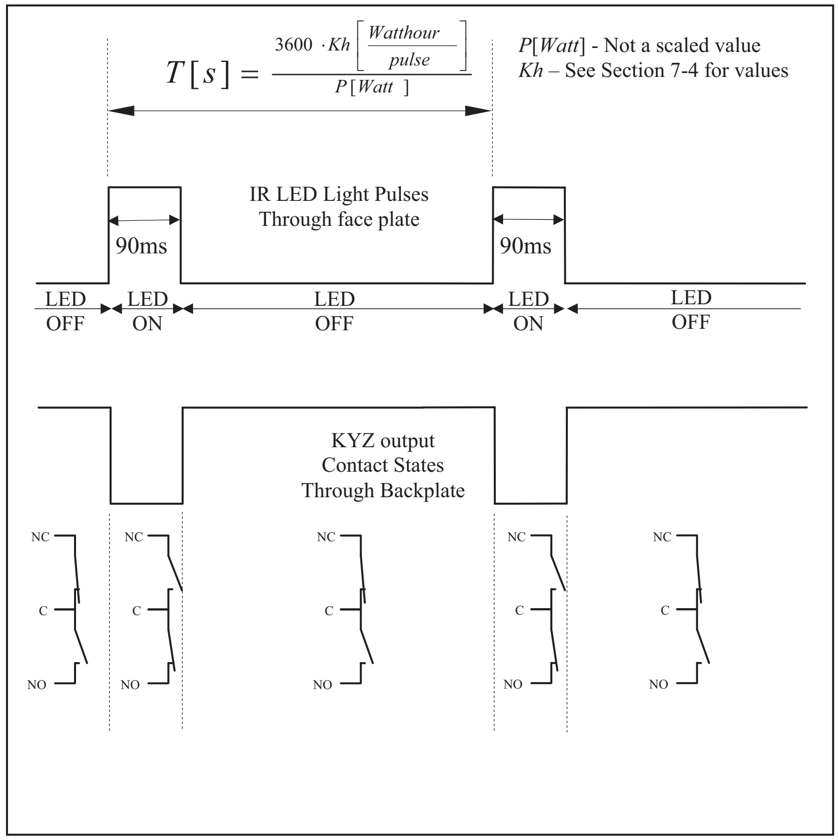
Peak Spectral Wavelength: 940nm

Reset State: Off

Internal Schematic: **Output Timing:**



(De-energized state)



2.3: Compliance

- IEC 62053-22 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- IEC1000-4-2: ESD
- IEC1000-4-3: Radiated Immunity
- IEC1000-4-4: Fast Transient
- IEC1000-4-5: Surge Immunity
- UL Listed
- CE Compliant

2.4: Accuracy

For 23^{o}C, 3 Phase balanced Wye or Delta load, at 50 or 60 Hz (as per order), 5A (Class 10) nominal unit:

Parameter	Accuracy	Accuracy Input Range
Voltage L-N [V]	0.1% of reading[2]	(69 to 480)V
Voltage L-L [V]	0.1% of reading	(120 to 600)V
Current Phase [A]	0.1% of reading[1]	(0.15 to 5)A
Current Neutral (calculated) [A]	2.0% of Full Scale[1]	(0.15 to 5)A @ (45 to 65)Hz
Active Power Total [W]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Active Energy Total [Wh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Reactive Power Total [VAR]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF
Reactive Energy Total [VARh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF
Apparent Power Total [VA]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF

Apparent Energy Total [VAh]	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Power Factor	0.2% of reading[1,2]	(0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF
Frequency	+/- 0.01Hz	(45 to 65)Hz
Load Bar	+/- 1 segment	(0.005 to 6)A

[1] For 2.5 element programmed units, degrade accuracy by an additional 0.5% of reading.

- For 1A (Class 2) Nominal, degrade accuracy by an additional 0.5% of reading.
- For 1A (Class 2) Nominal, the input current range for Accuracy specification is 20% of the values listed in the table.

[2] For unbalanced voltage inputs where at least one crosses the 150V auto-scale threshold (for example, 120V/120V/208V system), degrade accuracy by additional 0.4%.

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3: Mechanical Installation

3.1: Overview

The Shark® 200S meter can be installed on any wall. See Chapter 4 for wiring diagrams.

Mount the meter in a dry location, which is free from dirt and corrosive substances.

Recommended Tools for Shark® 200S Installation

- #2 Phillips screwdriver
- Wire cutters

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

3.2: Install the Base

1. Determine where you want to install the submeter.

2. **With the submeter power off**, open the top of the submeter. Use the front cover support to keep the cover open as you perform the installation (see Figure 3.1).

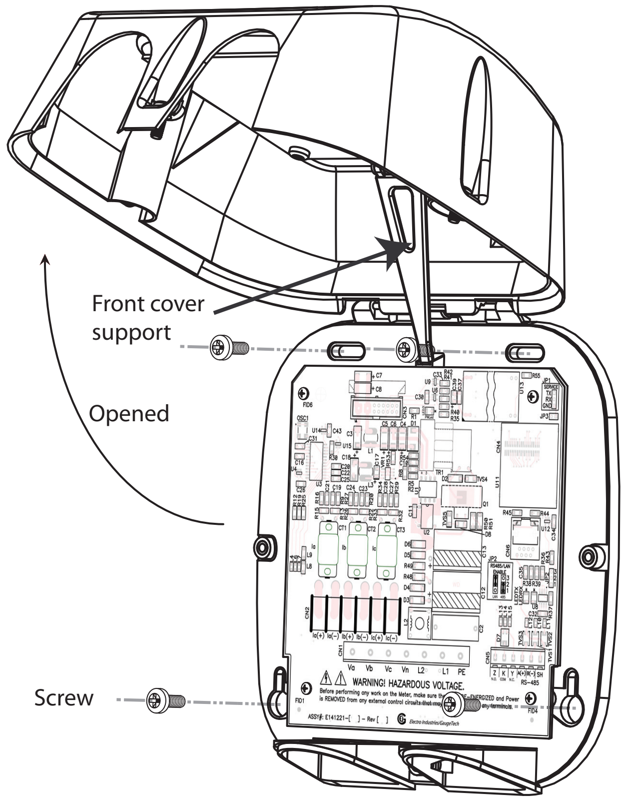

Figure 3.1: Shark Submeter with Cover Open

CAUTIONS!

- Remove the antenna before opening the unit.
- Only use the front cover support if you are able to open the front cover to the extent that you can fit the front cover support into its base. **DO NOT** rest the front cover support on the inside of the meter, even for a short time - by doing so, you may damage components on the board assembly.

3. Find the 4 Installation Slots and insert screws through each slot into the wall or panel.

4. Fasten securely - DO NOT overtighten.

3.2.1:Mounting Diagrams

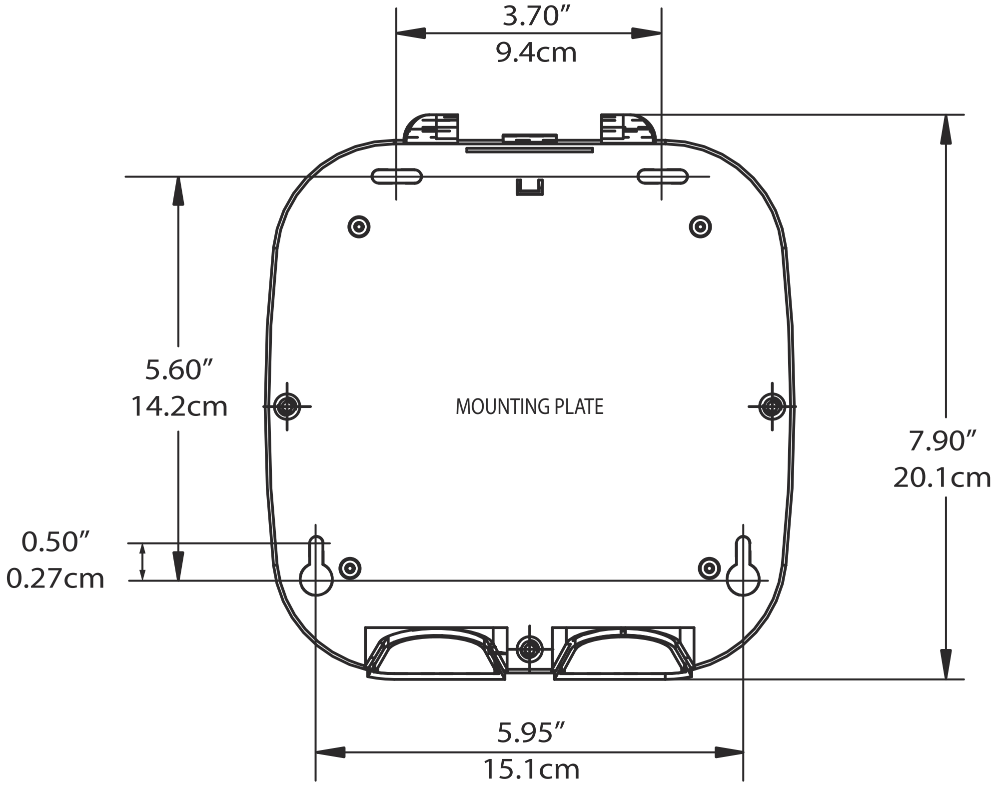

Figure 3.2: Mounting Plate Dimensions

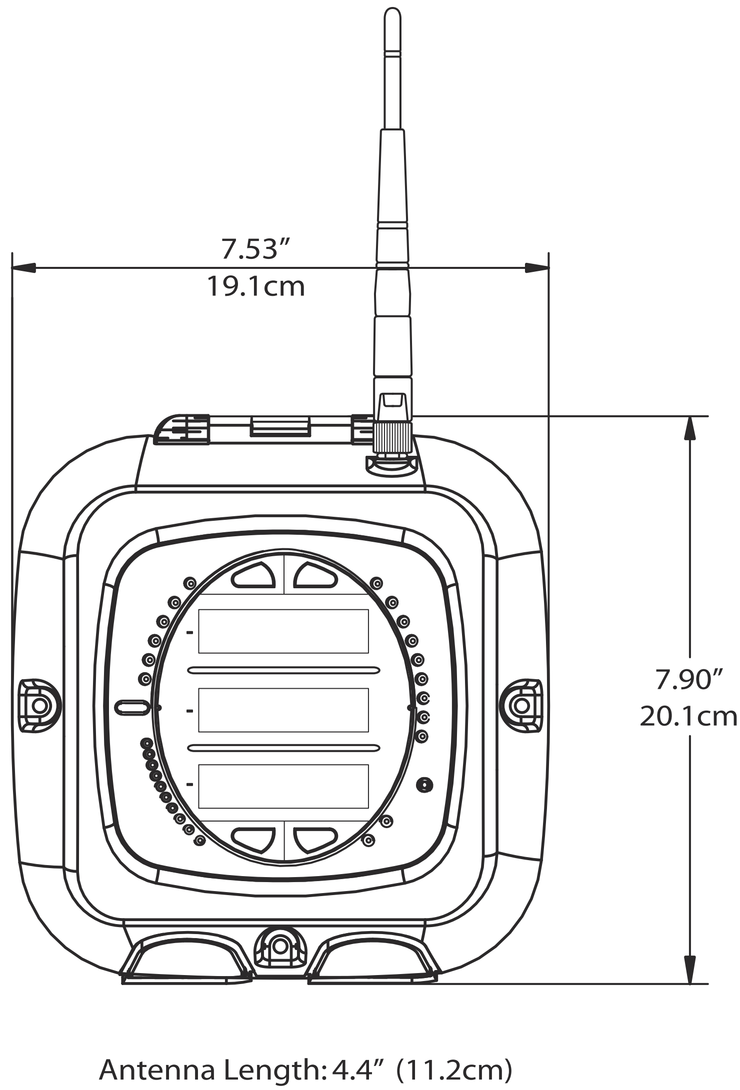

Figure 3.3: Front Dimensions

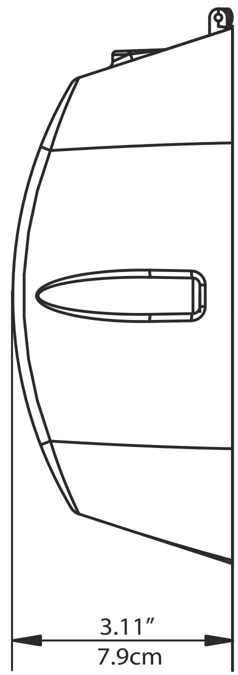

Figure 3.4: Side Dimensions

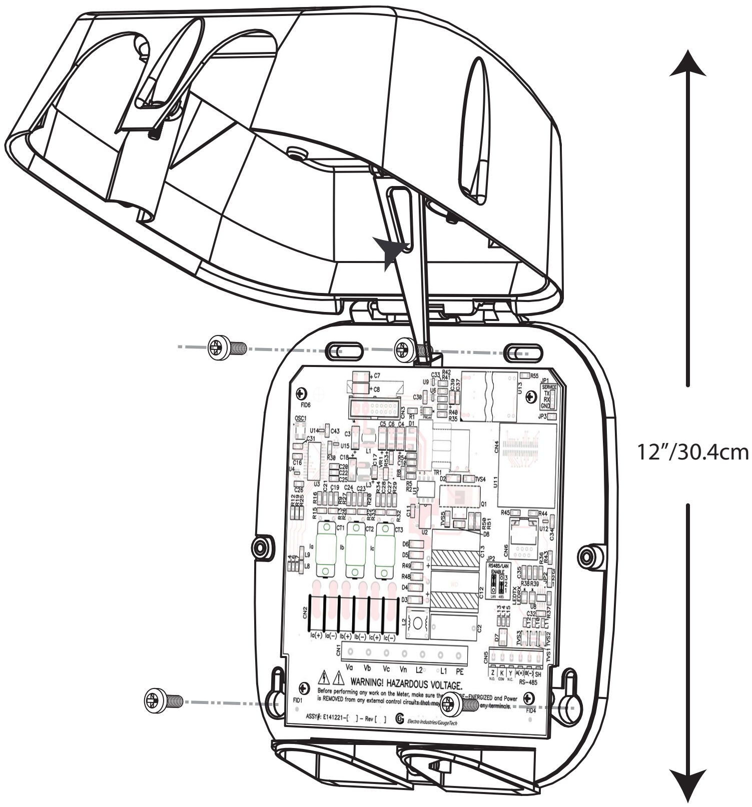

Figure 3.5: Open Cover Dimensions

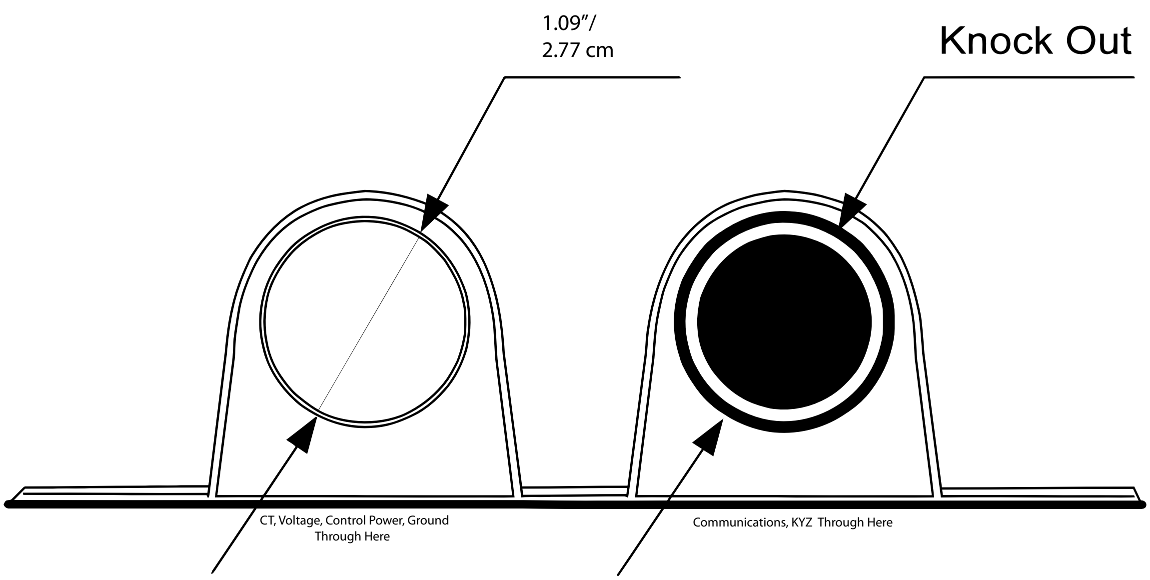

Figure 3.6: Bottom View with Access Holes

3.3: Secure the Cover

1. Close the cover, making sure that power and communications wires exit the submeter through the openings at the base (see Figure 3.6).

CAUTION! To avoid damaging components on the board assembly, make sure the front cover support is in the upright position before closing the front cover.

2. Using the 3 enclosed screws, secure the cover to the base in three places - DO NOT overtighten (you may damage the cover).

3. The unit can be sealed after the front cover is closed. To seal the unit, thread the seal tag through the housing located between the bottom access holes (see figures 3.6 and 3.7).

4. Reattach the antenna, if applicable.

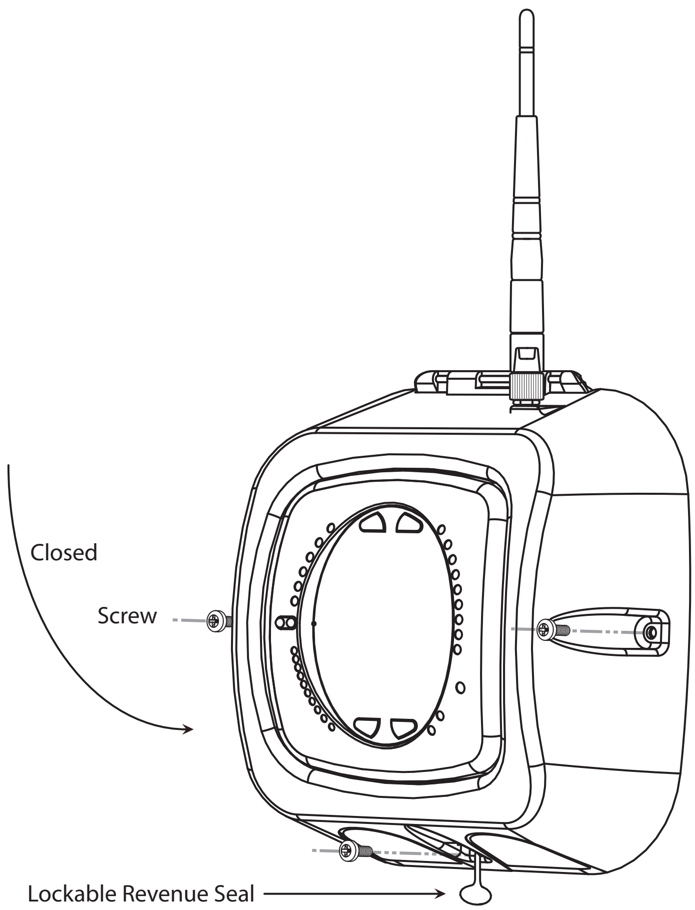

Figure 3.7: Submeter with Closed Cover

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4: Electrical Installation

4.1: Considerations When Installing Meters

Installation of the Shark® 200S meter must be performed only by qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing is recommended.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

Do not use the meter or any I/O Output Device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection.

Do not use the meter for applications where failure of the meter may cause harm or death.

Do not use the meter for any application where there may be a risk of fire.

All meter terminals should be inaccessible after installation.

Do not apply more than the maximum voltage the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages.

Do not HIPOT/Dielectric test any Outputs, Inputs or Communications terminals.

EIG recommends the use of Shorting Blocks and Fuses for voltage leads and power supply to prevent hazardous voltage conditions or damage to CTs, if the meter needs to be removed from service. CT grounding is optional.

IMPORTANT!

- IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

- THERE IS NO REQUIRED PREVENTIVE MAINTENANCE OR INSPECTION NECESSARY FOR SAFETY. HOWEVER, ANY REPAIR OR MAINTENANCE SHOULD BE PERFORMED BY THE FACTORY.

DISCONNECT DEVICE: The following part is considered the equipment disconnect device. A SWITCH OR CIRCUIT-BREAKER SHALL BE INCLUDED IN THE END-USE EQUIPMENT OR BUILDING INSTALLATION. THE SWITCH SHALL BE IN CLOSE PROXIMITY TO THE EQUIPMENT AND WITHIN EASY REACH OF THE OPERATOR. THE SWITCH SHALL BE MARKED AS THE DISCONNECTING DEVICE FOR THE EQUIPMENT.

4.2: Electrical Connections

All wiring for the Shark® 200S is done through the front of the unit (lifting the cover with the power to the unit OFF) so that the unit can be surface mounted. Connecting cables exit the unit via two openings in the base plate (see figures 3.5 and 4.1).

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

CAUTION! DO NOT over-torque screws.

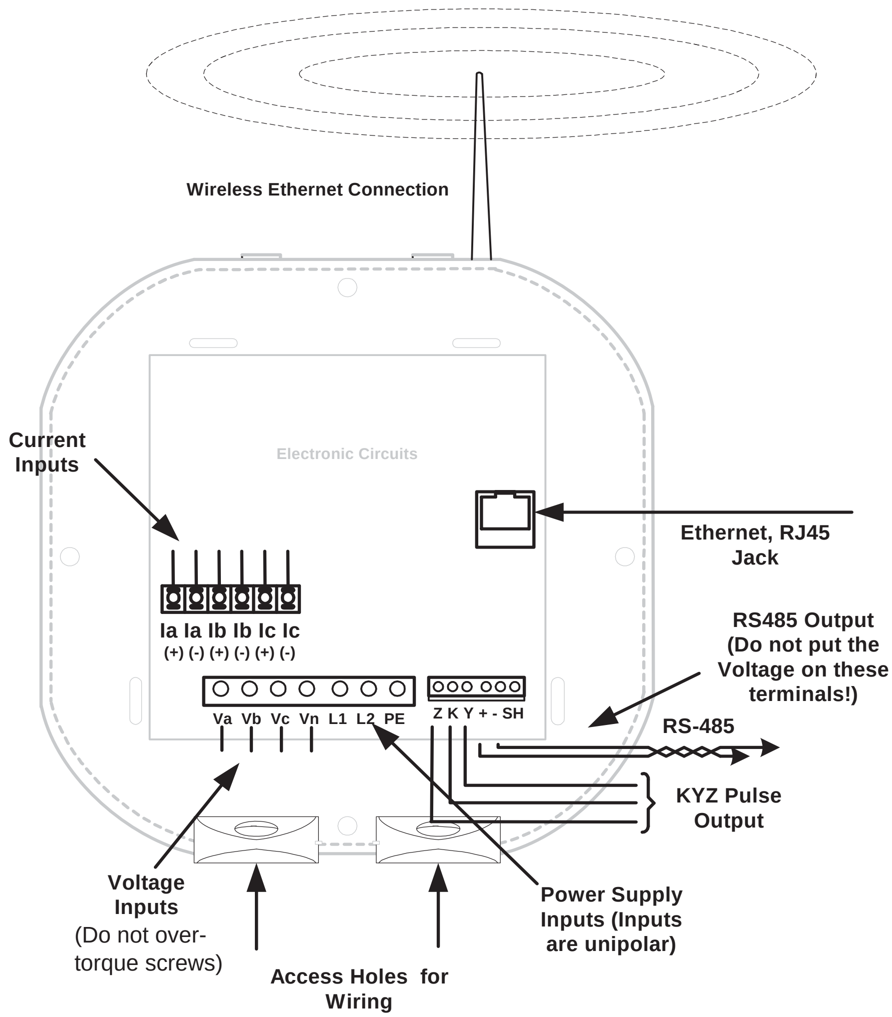


Figure 4.1: Submeter Connections

4.3: Ground Connections

The meter's Ground Terminal (PE) should be connected directly to the installation's protective earth ground.

4.4: Voltage Fuses

EIG recommends the use of fuses on each of the sense voltages and on the control power, even though the wiring diagrams in this chapter do not show them.

- Use a 0.1 Amp fuse on each Voltage input.
- Use a 3 Amp fuse on the power supply.

4.5: Electrical Connection Diagrams

Choose the diagram that best suits your application. Make sure the CT polarity is correct.

1. Three Phase, Four-Wire System Wye with Direct Voltage, 3 Element

   a. Dual Phase Hookup

   b. Single Phase Hookup

3. Three Phase, Four-Wire System Wye with Direct Voltage, 2.5 Element

4. Three-Phase, Four-Wire Wye with PTs, 3 Element

5. Three-Phase, Four-Wire Wye with PTs, 2.5 Element

6. Three-Phase, Three-Wire Delta with Direct Voltage (No PTs, 2 CTs)

7. Three-Phase, Three-Wire Delta with Direct Voltage (No PTs, 3 CTs)

8. Three-Phase, Three-Wire Delta with 2 PTs, 2 CTs

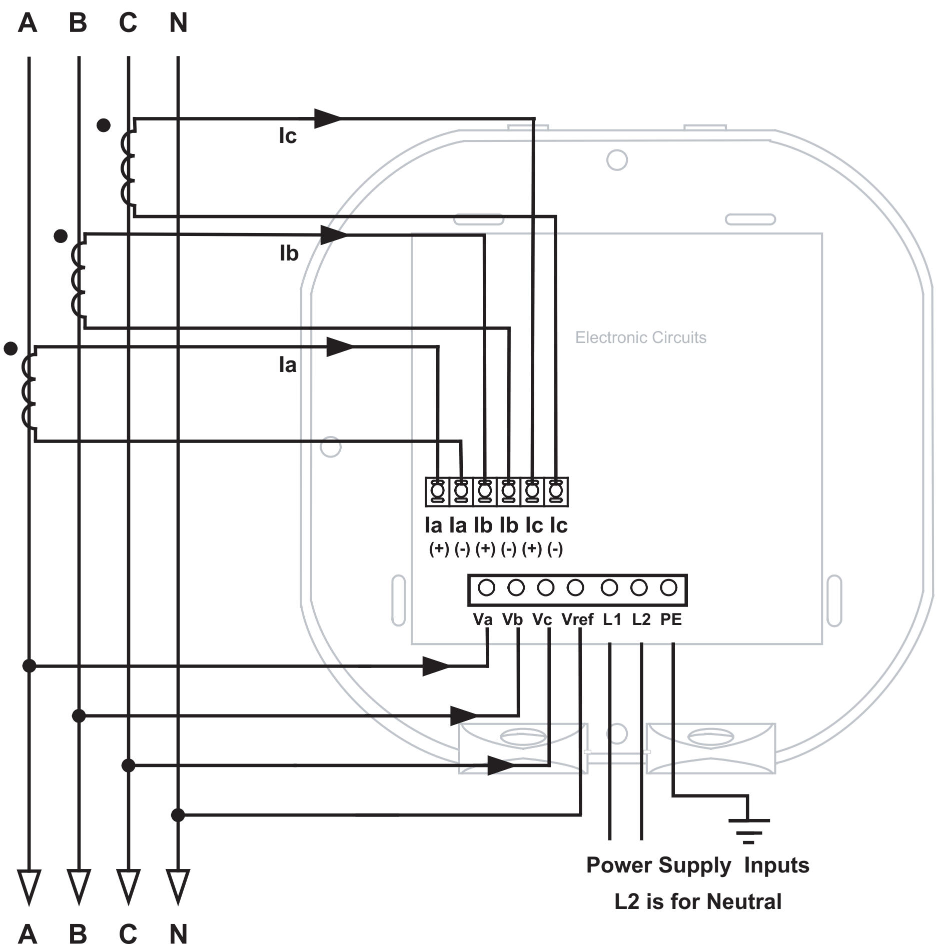
9. Three-Phase, Three-Wire Delta with 2 PTs, 3 CTs

10. Current Only Measurement (Three Phase)

11. Current Only Measurement (Dual Phase)

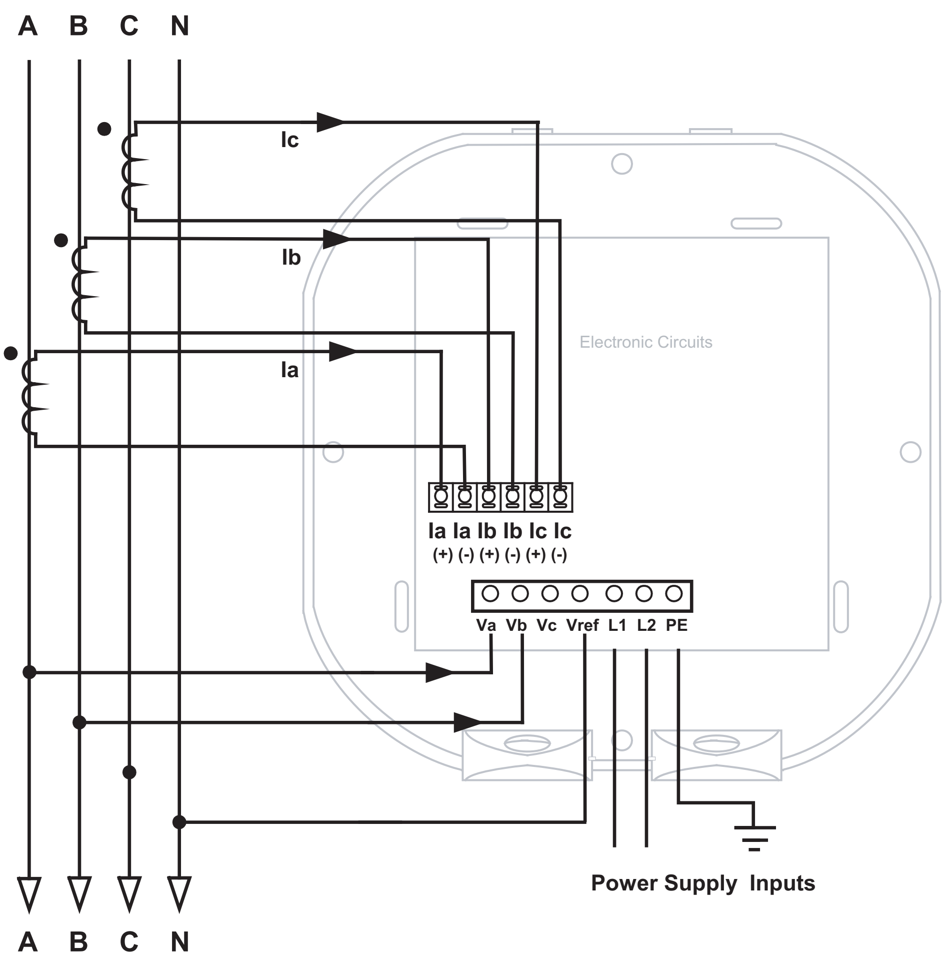
12. Current Only Measurement (Single Phase)

1. Service: WYE, 4-Wire with No PTs, 3 CTs

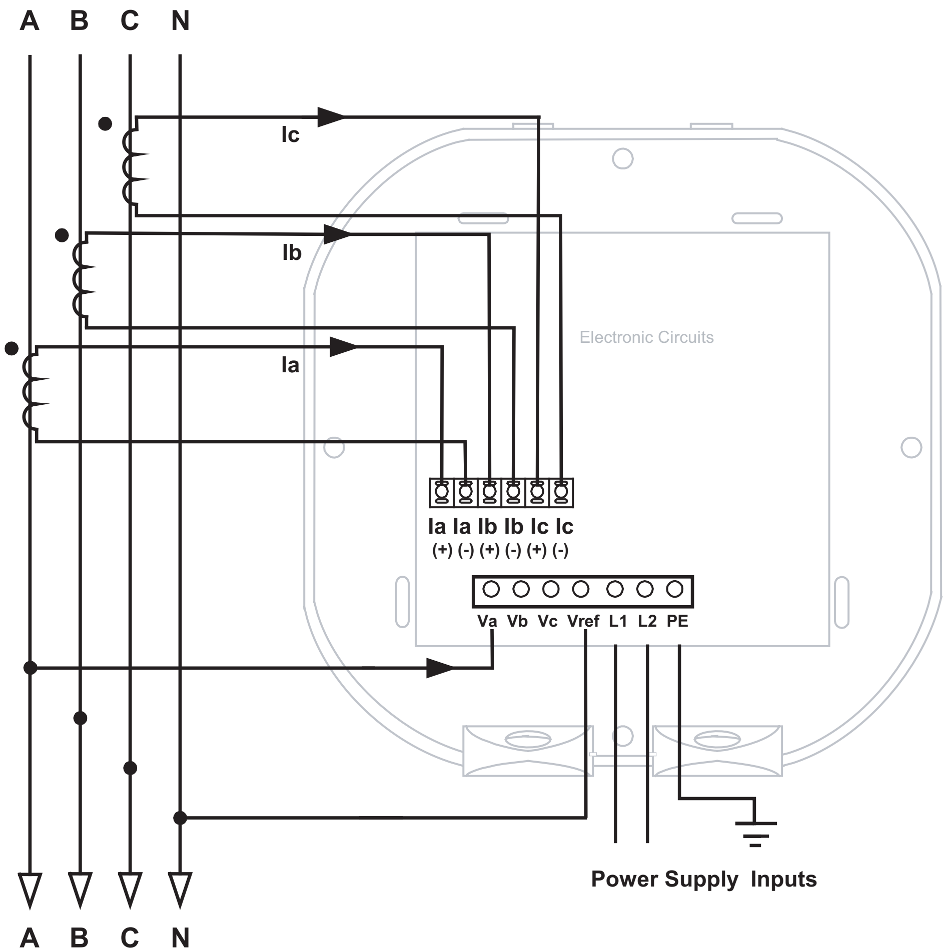


Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

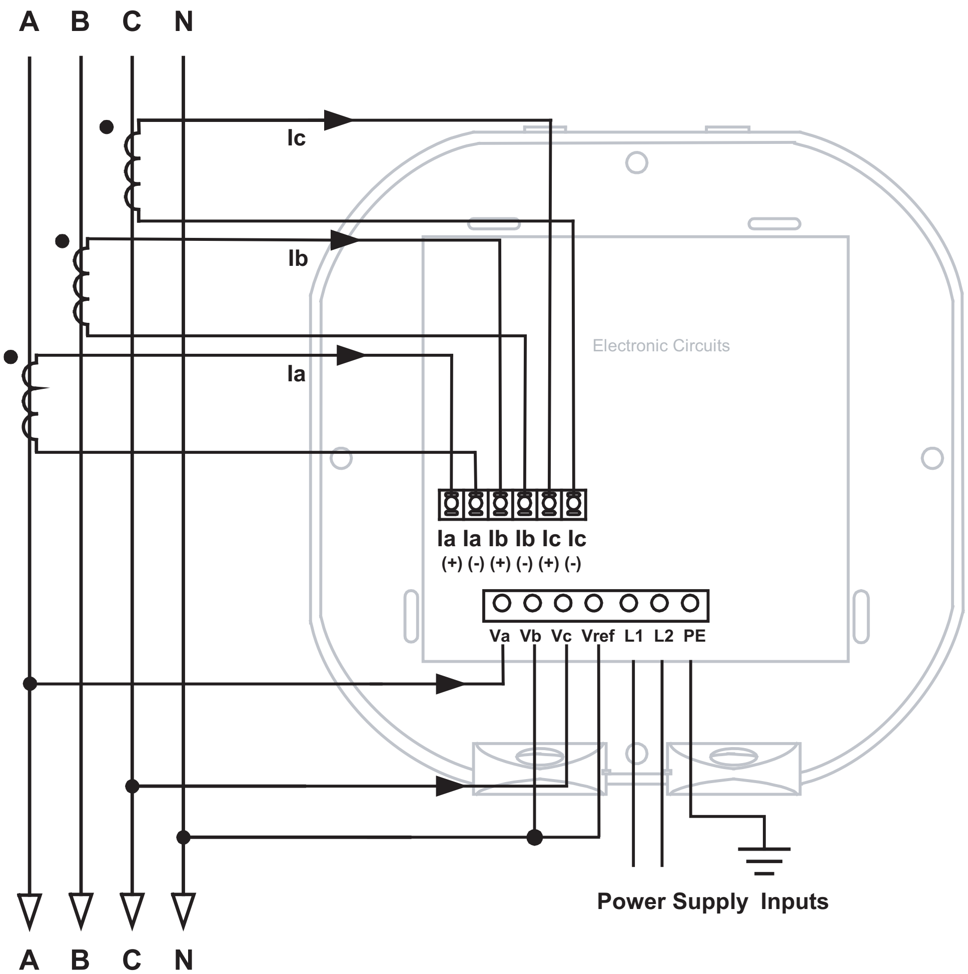
1a. Dual Phase Hookup



1b. Single Phase Hookup

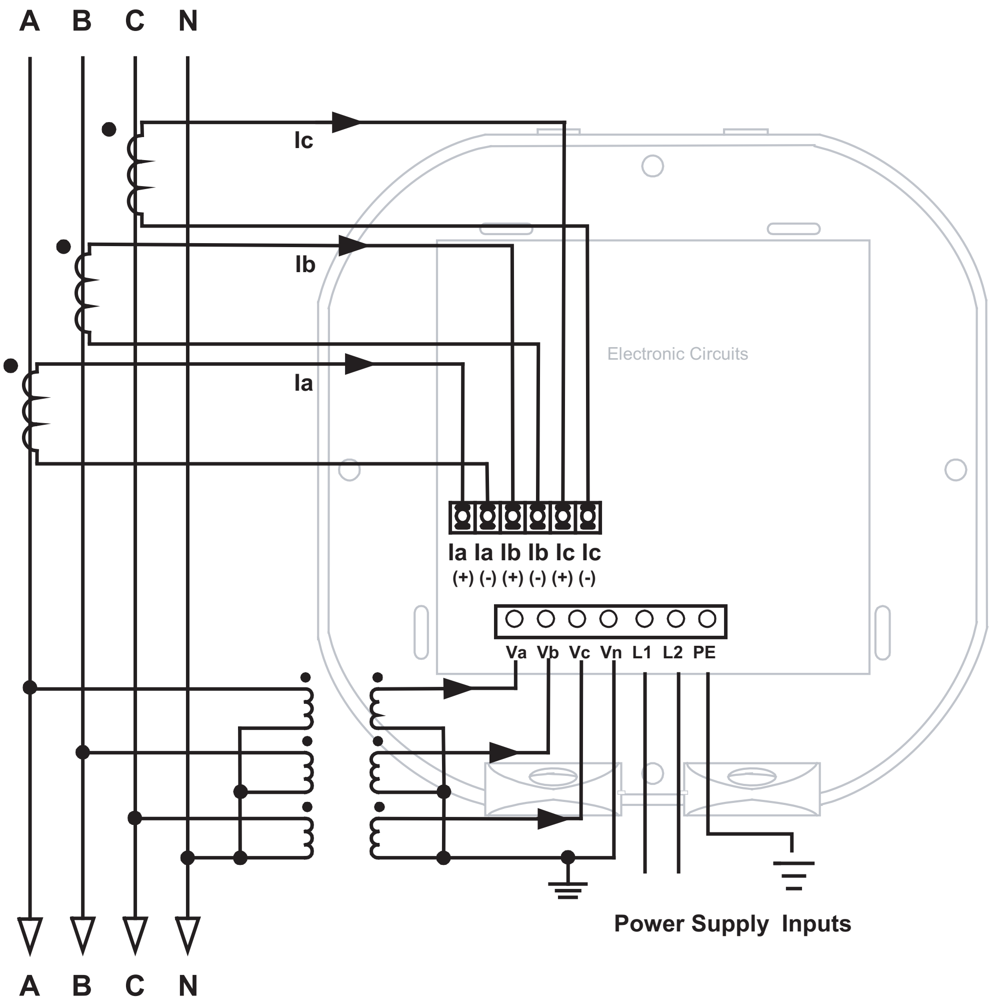


2. Service: 2.5 Element WYE, 4-Wire with No PTs, 3 CTs



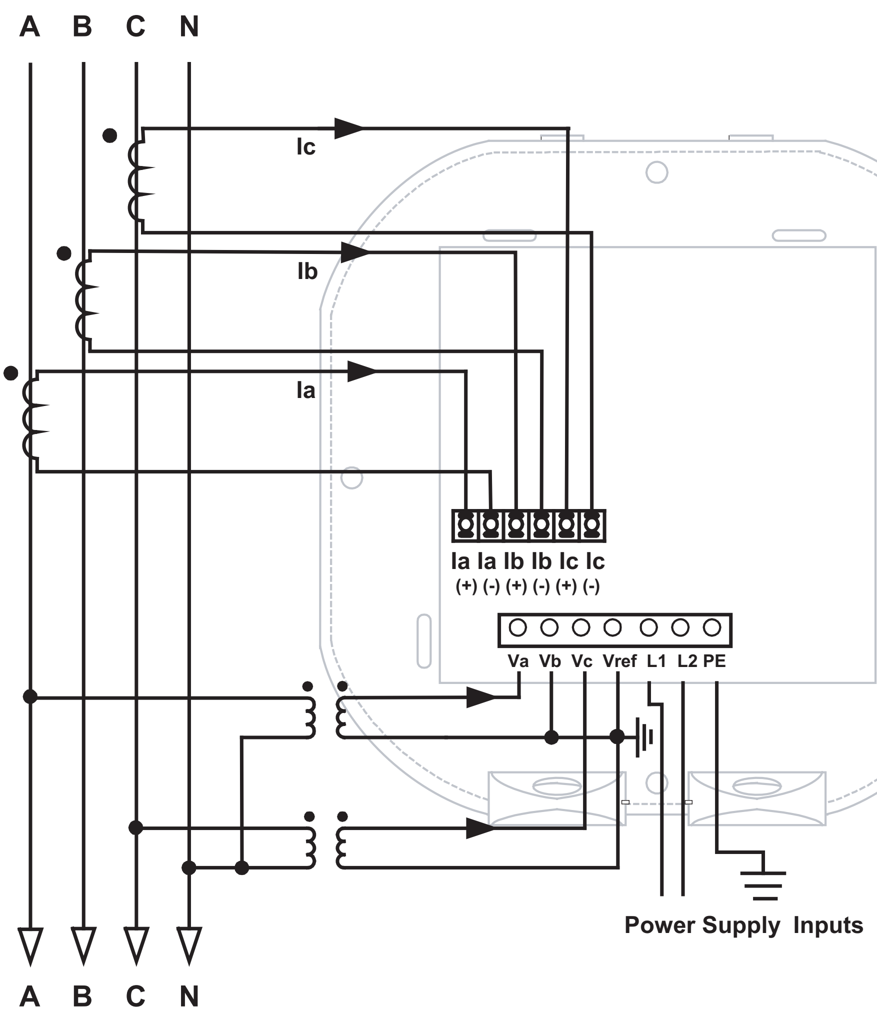
Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.

3. Service: WYE, 4-Wire with 3 PTs, 3 CTs



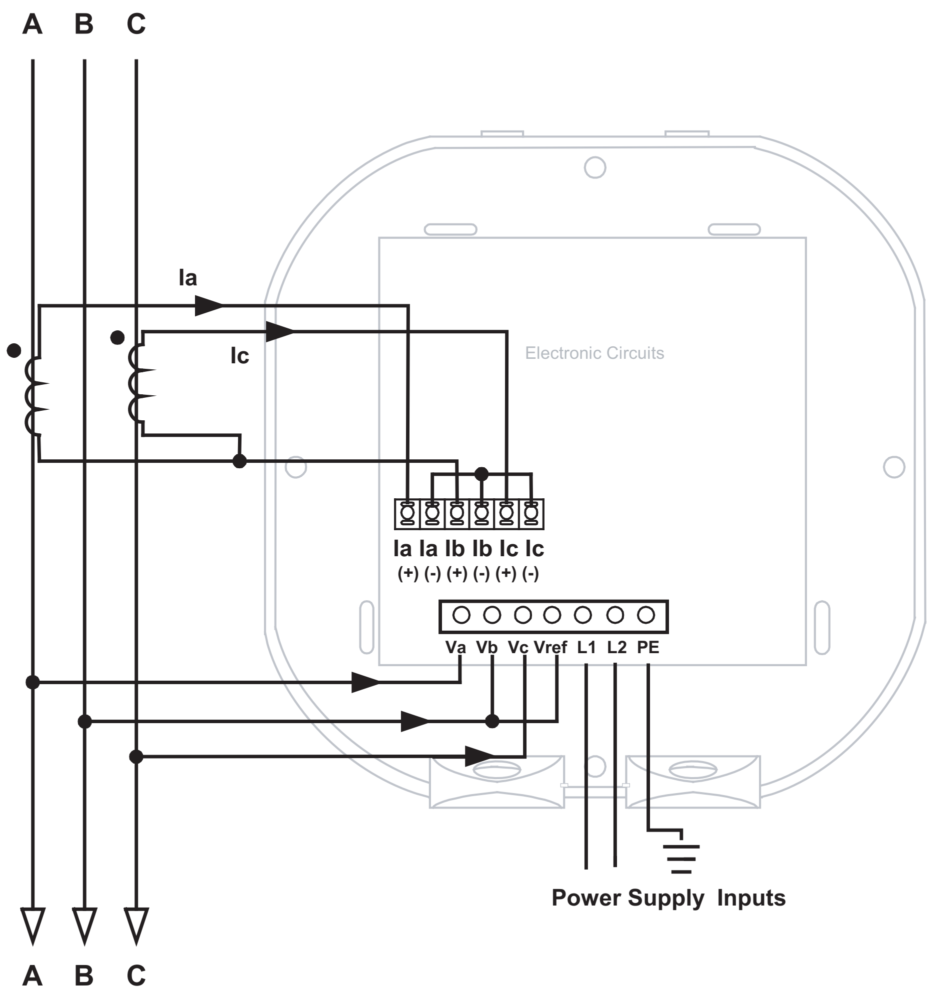
Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

4. Service: 2.5 Element WYE, 4-Wire with 2 PTs, 3 CTs



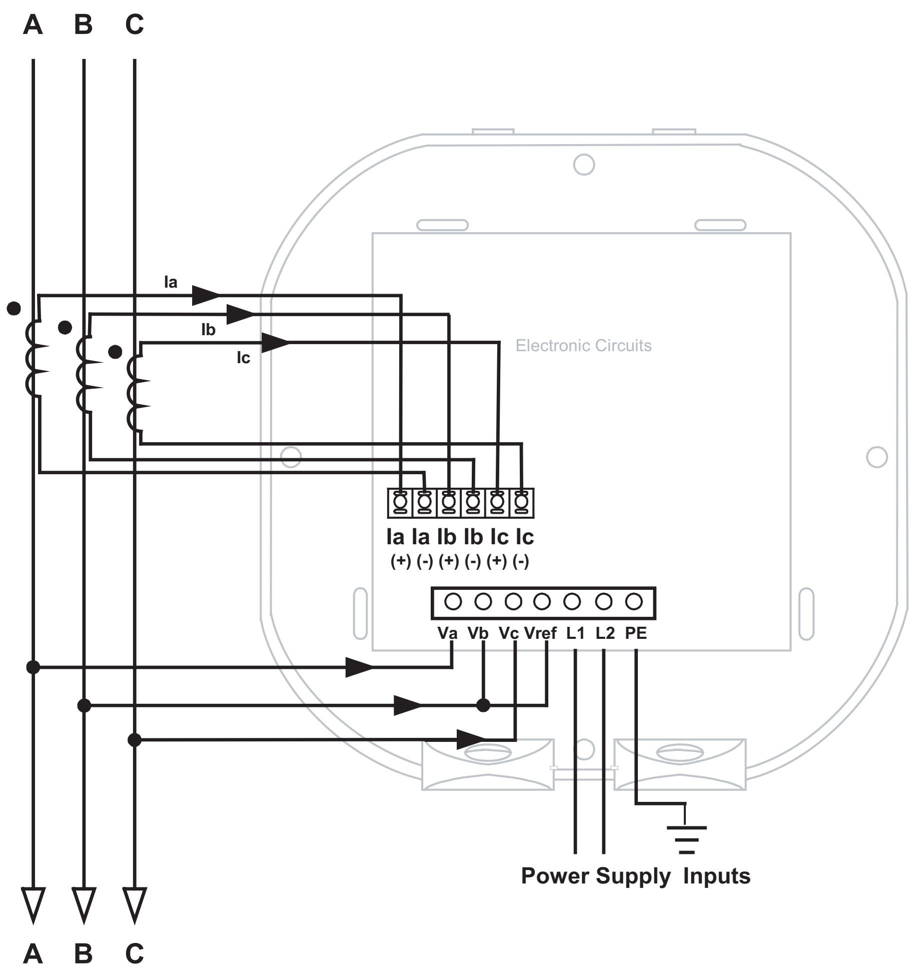
Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.

5. Service: Delta, 3-Wire with No PTs, 2 CTs



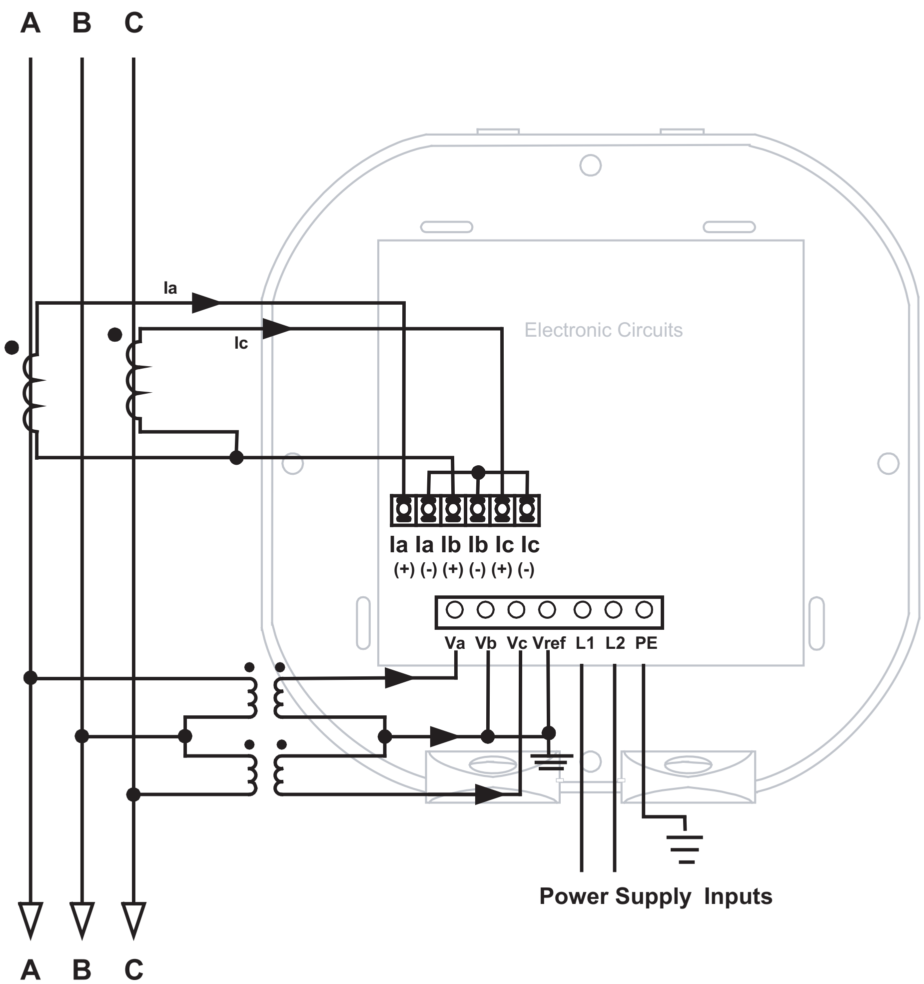
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

6. Service: Delta, 3-Wire with No PTs, 3 CTs



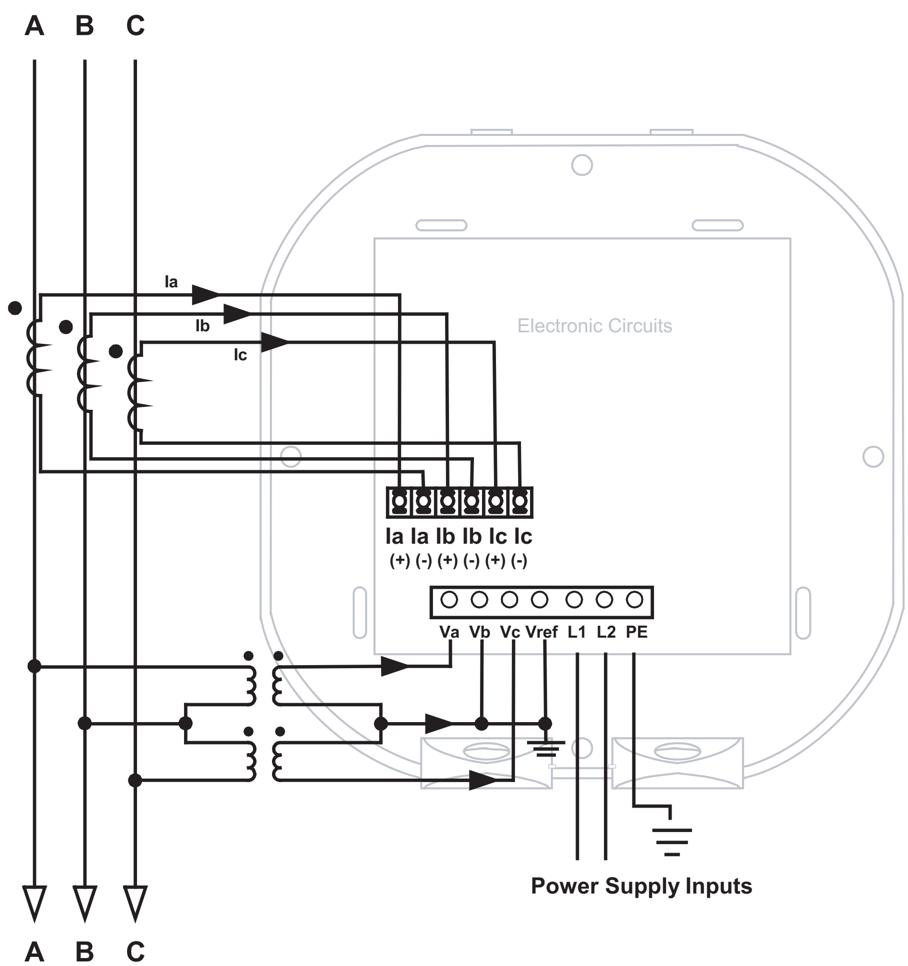
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

7. Service: Delta, 3-Wire with 2 PTs, 2 CTs



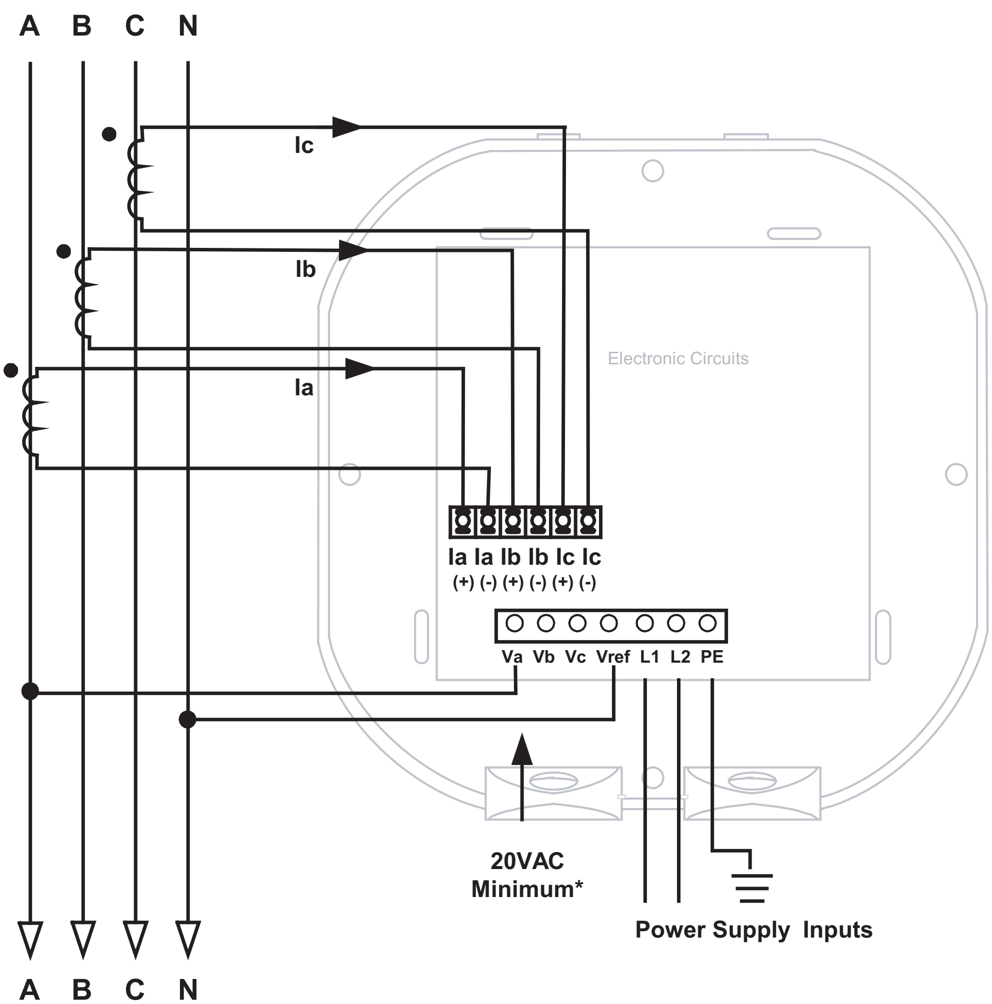
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

8. Service: Delta, 3-Wire with 2 PTs, 3 CTs



Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

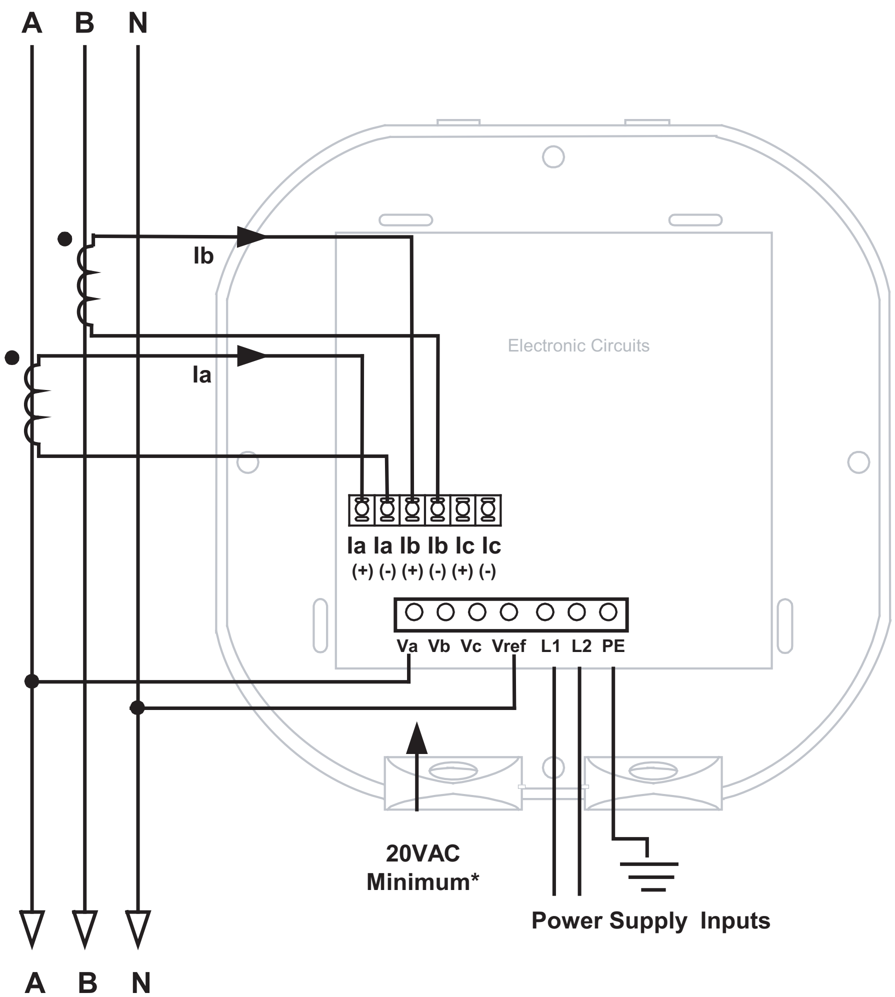
9. Service: Current Only Measurement (Three Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

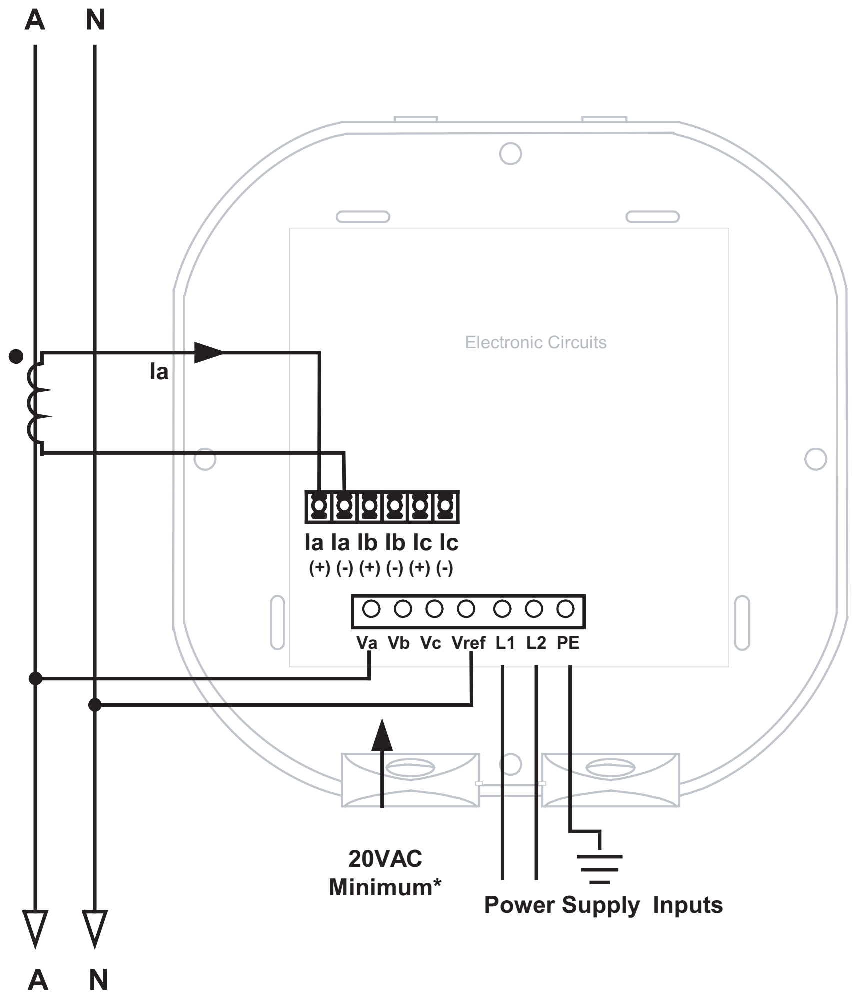
10. Service: Current Only Measurement (Dual Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

11. Service: Current Only Measurement (Single Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

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5: Communication Installation

5.1: Shark® 200S Communication

The Shark® 200S submeter provides two independent communication ports plus a KYZ pulse output. The first port, Com 1, is an IrDA Port, which uses Modbus ASCII. The second port, Com 2, provides RS485 or RJ45 Ethernet or WiFi Ethernet communication (see Chapter 6 for Ethernet communication).

5.1.1: IrDA Port (Com 1)

The Com 1 IrDA port is located on the face of the submeter. The IrDA Port allows the unit to be set up and programmed with any device capable of IrDA communication, such as an IrDA-equipped laptop PC or a USB/IrDA wand (such as the USB to IrDA Adapter [CAB6490] described in Appendix D).

IrDA port settings are

Address: 1

Baud Rate: 57600 Baud

Protocol: Modbus ASCII

Figure 5.1: IrDA Communication

5.1.1.1: USB to IrDA Adapter

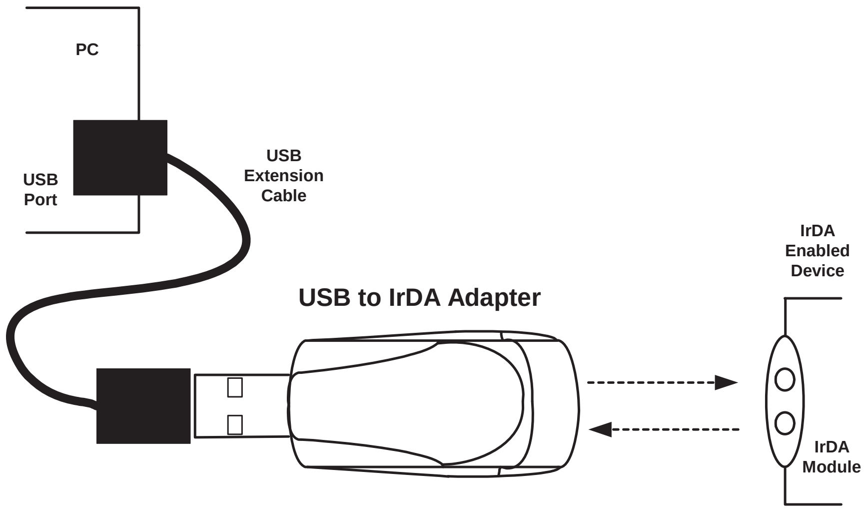


Figure 5.2: USB to IrDA Adapter

The USB to IrDA Adapter (CAB6490) enables IrDA wireless data communication through a standard USB port. The adapter is powered through the USB bus and does not require any external power adapter. The effective data transmission distance is 0 to .3 meters (approximately 1 foot).

The USB to IrDA Adapter enables wireless data transfer between a PC and the submeter. The adapter can also be used with other IrDA-compatible devices. The adapter is fully compatible with IrDA 1.1 and USB 1.1 specifications.

System Requirements

- IBM PC Pentium based computer
- 2 Gigabytes of RAM preferable
- Available USB port
- CD-ROM drive
- Windows 98, Windows XP, or Windows 7

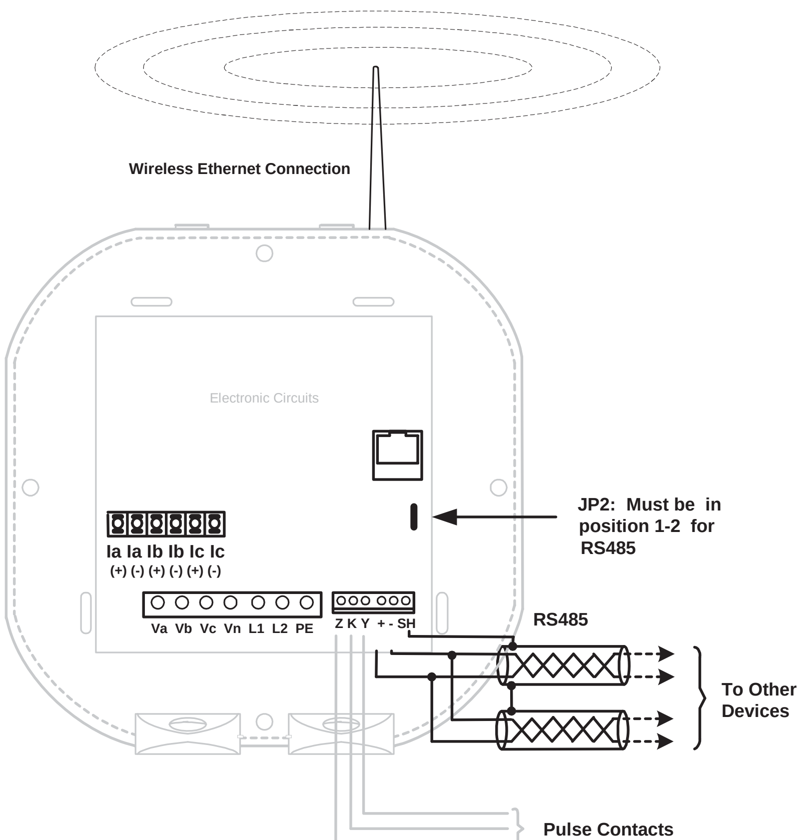
See Appendix D for instructions on using the USB to IrDA Adapter. You can order CAB6490 from EIG's webstore: www.electroind.com/store. Select Cables and Accessories from the list on the left side of the screen.

5.1.2: RS485 Communication Com 2 (485 Option)

The Shark® 200S submeter's RS485 port RS485 port uses standard 2-Wire, half duplex architecture. The RS485 connector is located on the front of the meter, under the cover. A connection can easily be made to a Master device or to other slave devices, as shown below.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

NOTE: Care should be taken to connect + to + and - to - connections.



The Shark® 100S submeter's RS485 connection can be programmed with the buttons on the face of the meter or by using Communicator EXT software.

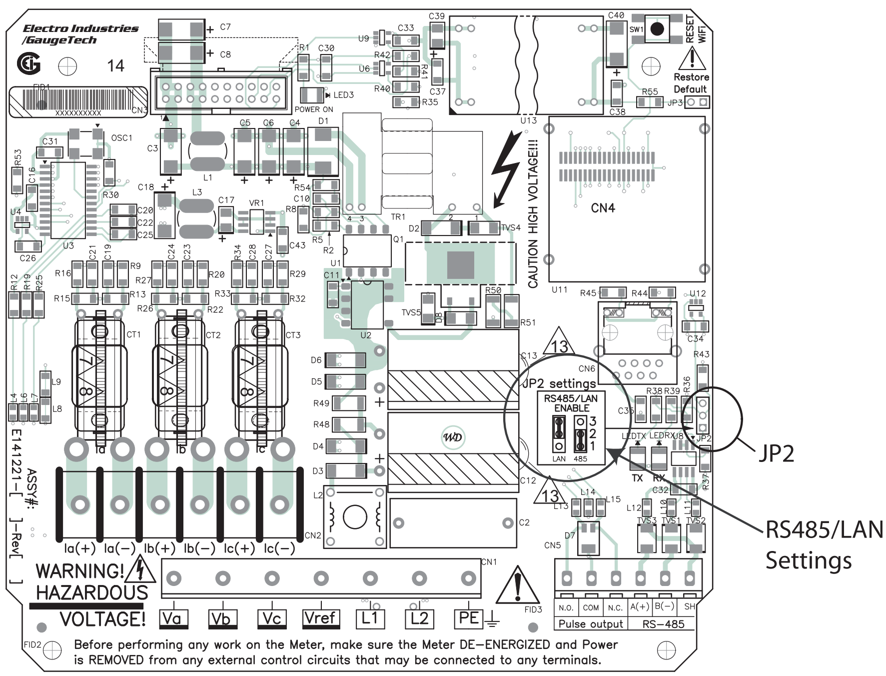
Standard RS485 Port Settings

Address: 001 to 247

Baud Rate: 9600, 19200, 38400 or 57600 Baud

Protocol: Modbus RTU, Modbus ASCII, or DNP 3.0

** The position of Jumper 2 (JP2) must be set for either RS485 or Ethernet communication. See the figure below. You put the jumper on positions 2 and 3 for LAN (Ethernet) communication, and on 1 and 2 for RS485 communication.

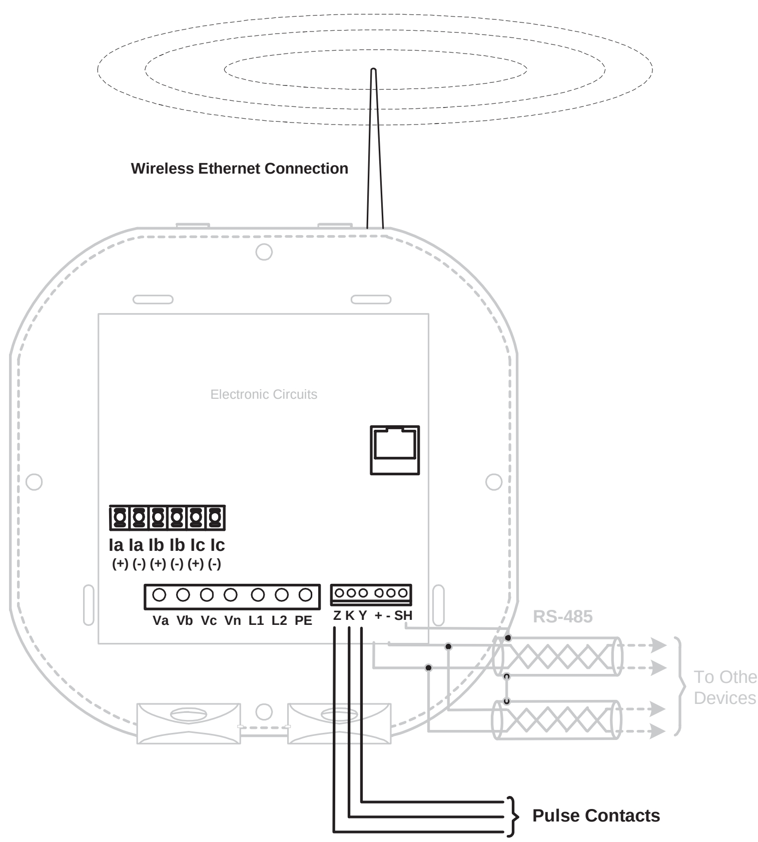


5.1.3: KYZ Output

The KYZ pulse output provides pulsing energy values that verify the submeter's readings and accuracy. The KYZ Pulse Output is located on the face of the meter, under the cover and just below the RS485 connection.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

See Section 2.2 for the KYZ output specifications; see Section 7.4 for pulse constants.



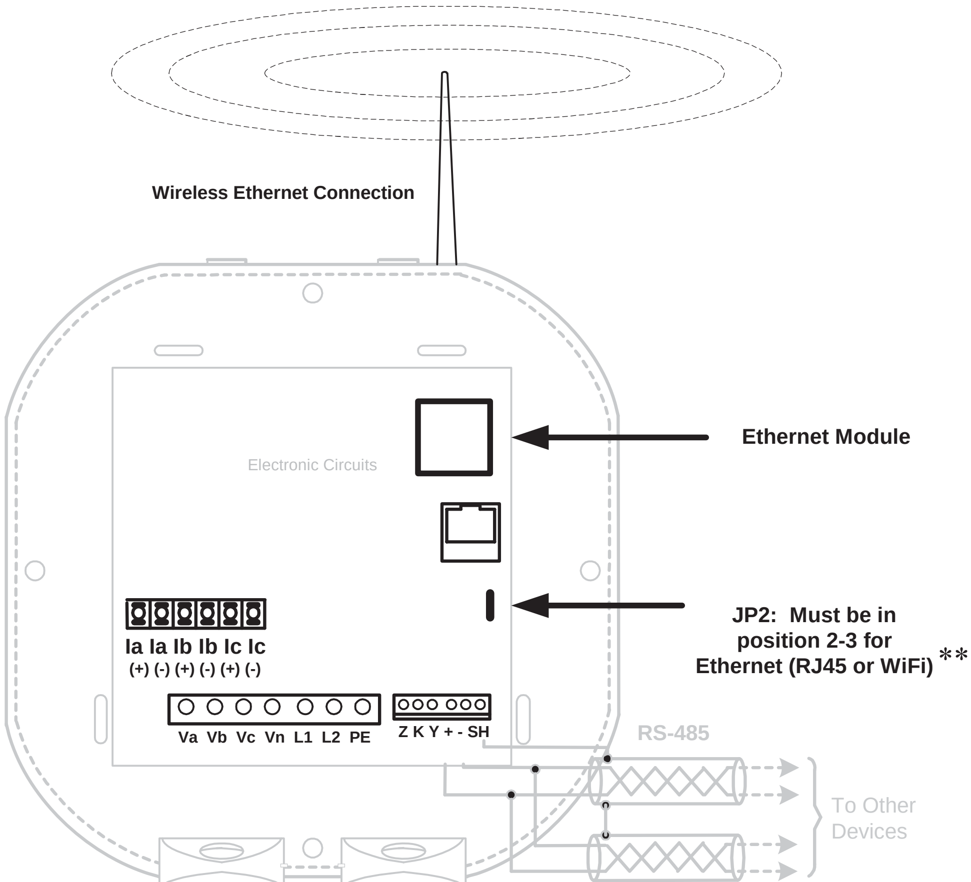
5.1.4: Ethernet Connection

In order to use the Shark® 200S submeter's Ethernet capability, the Ethernet Module must be installed in your meter, and the JP2 must be set to positions 2-3. You can use either wired Ethernet, or WiFi.

- For wired Ethernet, use Standard RJ45 10/100BaseT cable to connect to the Shark® 200S submeter. The RJ45 line is inserted into the RJ45 port of the meter.

- For WiFi connections, make sure you have the correct antenna attached to the meter.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**



Refer to Chapter 6 for instructions on how to set up the Network Module.

** See the JP2 figure and instructions on page 5-4.

5.2: Meter Communication and Programming Overview

Programming and communication can utilize the RS485 connection shown in Section 5.1.2 or the RJ45/WiFi connection shown in Section 5.1.4. Once a connection is established, Communicator EXT software can be used to program the meter and communicate to other devices.

Meter Connection

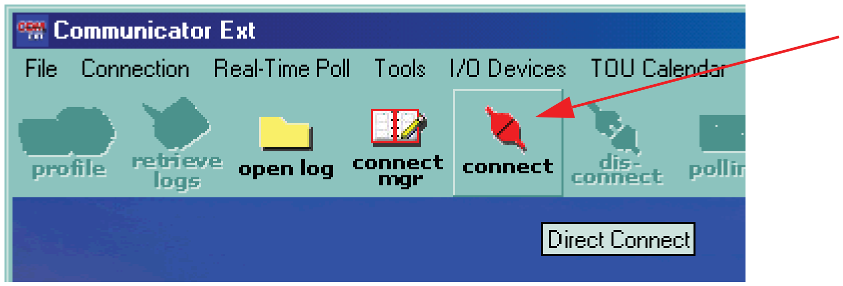
To provide power to the meter, use one of the wiring diagrams in Chapter 4 or attach an Aux cable to GND, L(+) and N(-).

The RS485 cable attaches to SH, - and + as shown in Section 5.1.2.

5.2.1: How to Connect to the Submeter

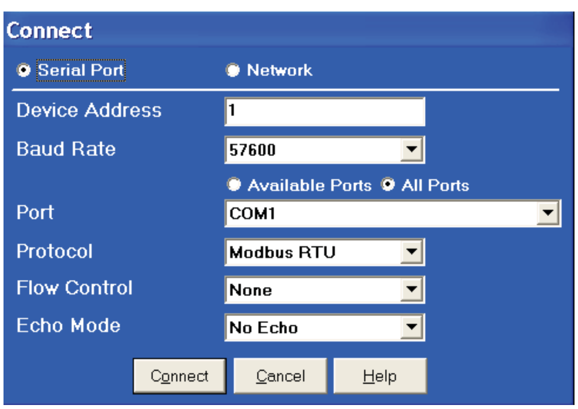
1. Open Communicator EXT software.

2. Click the **Connect** icon on the Icon bar.

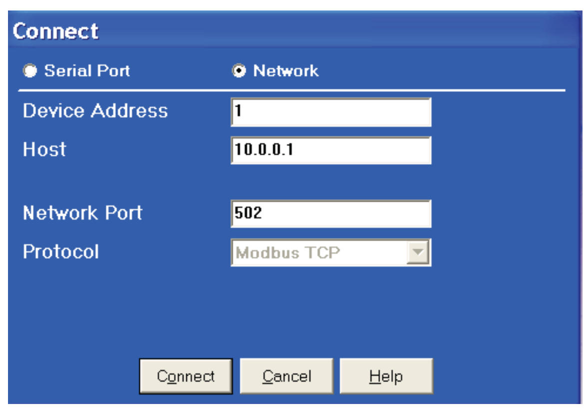


The Connect screen opens, showing the Initial settings. Make sure your settings are the same as those shown on the next page, except for the IP Address field, which must be your device's IP address.The address shown here is the default Ethernet option address.

NOTE: The settings you make will depend on whether you are connecting to the meter via Serial Port or Network. Use the pull-down menus to make any necessary changes.



Serial Port Connection



Network Connection

3. Click the **Connect** button on the screen.

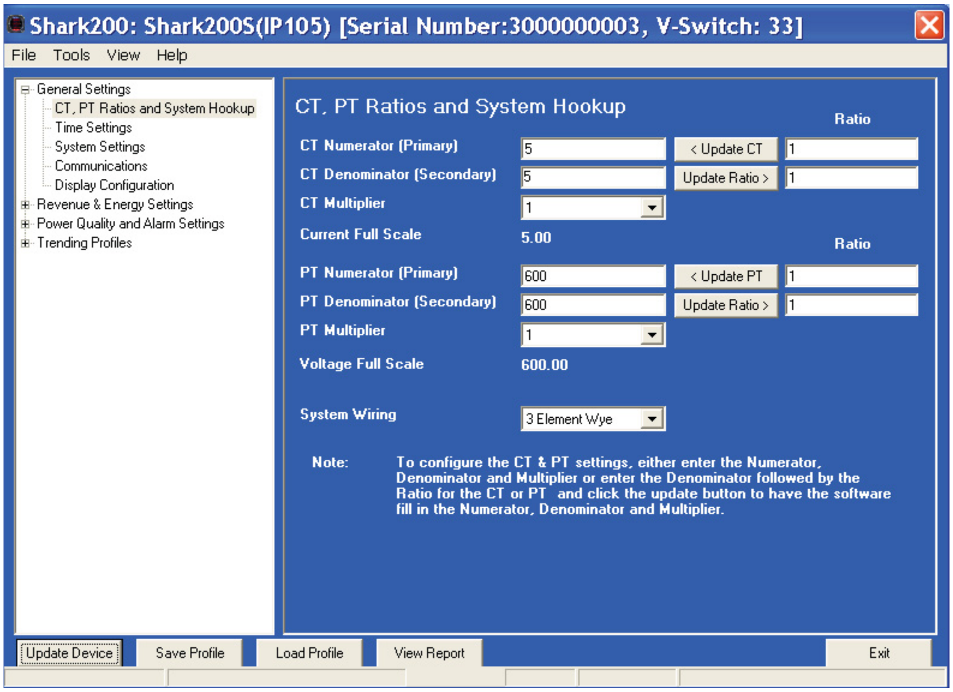
   NOTE: You may have to disconnect power, reconnect power and then click **Connect**.

   The Device Status screen appears, confirming a connection.

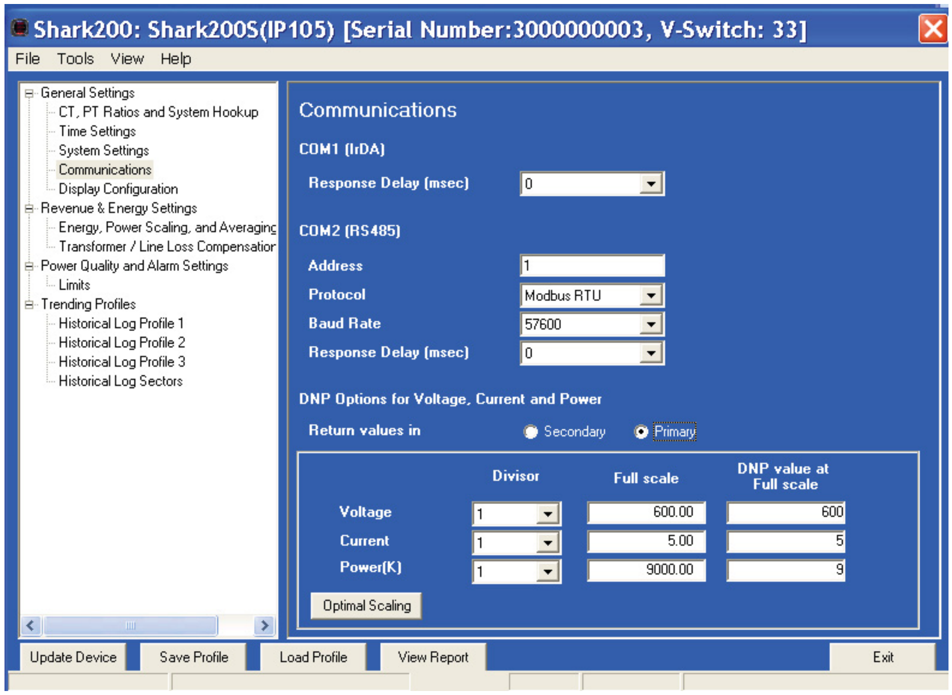
4. Click **OK**.

5. The Communicator EXT Main screen appears. Click the **Profile** icon in the Title Bar.

6. You will see the Shark® 200S meter’s Device Profile screen. Use the Tree menu on the left of the screen to navigate between settings screens (see below).



7. Click the **Communications** tab. You will see the screen shown below. Use this screen to enter communication settings for the meter's two on-board ports: the IrDA port (COM 1) and RS485 port (COM 2) Make any necessary changes to settings.



Valid Communication Settings are as follows:

COM1 (IrDA)

Response Delay (0-750 msec)

COM2 (RS485)

Address (1-247)

Protocol (Modbus RTU, Modbus ASCII or DNP)

Baud Rate (9600 to 57600)

Response Delay (0-750 msec)

DNP Options for Voltage, Current, and Power - these fields allow you to choose Primary or Secondary Units for DNP, and to set custom scaling if you choose Primary. See Chapter 5 in the *Communicator EXT User Manual* for more information.

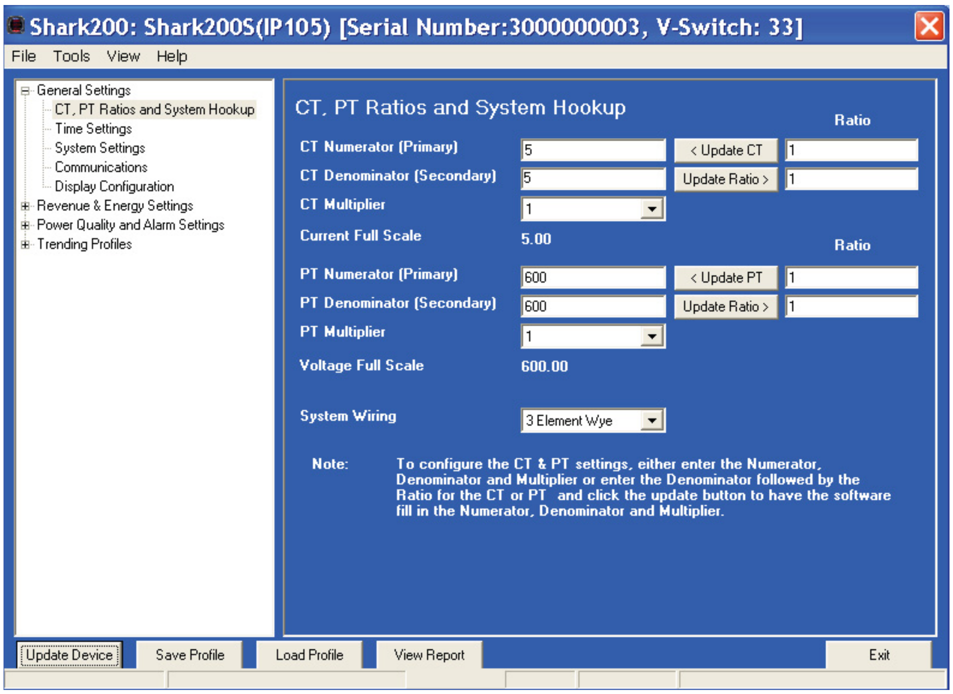
8. When changes are complete, click the **Update Device** button to send a new profile to the meter.

9. Click **Exit** to leave the Device Profile or click other menu items to change other aspects of the Device Profile (see the following section for instructions).

5.2.2: Shark® 200S Meter Device Profile Settings

NOTE: Only the basic Shark® 200S meter Device Profile settings are explained in this manual. Refer to Chapter 5 in the *Communicator EXT User Manual* for detailed instructions on configuring all settings of the meter's Device Profile. You can view the manual online by clicking **Help>Contents** from the Communicator EXT Main screen.

CT, PT Ratios and System Hookup



The screen fields and acceptable entries are as follows:

CT Ratios

CT Numerator (Primary): 1 - 9999

CT Denominator (Secondary): 5 or 1 Amp

NOTE: This field is display only.

CT Multiplier: 1, 10 or 100

Current Full Scale: Display only

PT Ratios

PT Numerator (Primary): 1 - 9999

PT Denominator (Secondary): 40 - 600

PT Multiplier: 1, 10, 100, or 1000

Voltage Full Scale: Display only

System Wiring

3 Element Wye; 2.5 Element Wye; 2 CT Delta

NOTE: Voltage Full Scale = PT Numerator x PT Multiplier

Example:

A 14400/120 PT would be entered as:

PT Numerator:	1440
PT Denominator:	120
Multiplier:	10

This example would display a 14.40kV.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200, Ct-Multiplier value for 1

800/5 Amps: Set the Ct-n value for 800, Ct-Multiplier value for 1

2,000/5 Amps: Set the Ct-n value for 2000, Ct-Multiplier value for 1

10,000/5 Amps: Set the Ct-n value for 1000, Ct-Multiplier value for 10

Example PT Settings:

277/277 Volts: Pt-n value is 277, Pt-d value is 277, Pt-Multiplier is 1

14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-Multiplier value is 10

138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-Multiplier value is 100

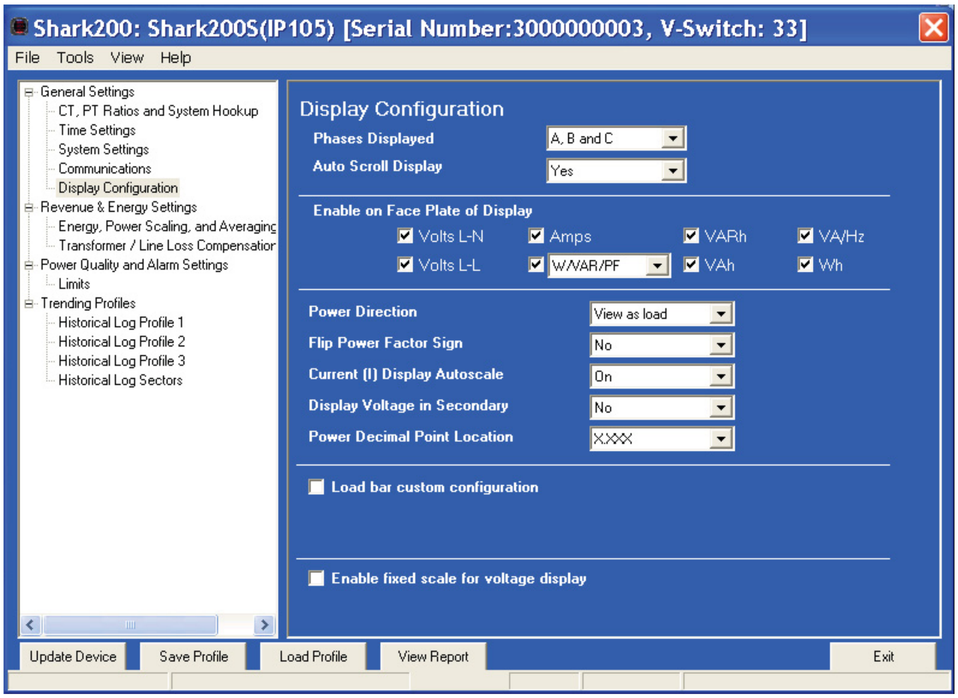
345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-Multiplier value is 100

345,000/69 Volts: Pt-n value is 345, Pt-d value is 69, Pt-Multiplier value is 1000

NOTE: Settings are the same for Wye and Delta configurations.

Display Configuration

The settings on this screen determine the display configuration of the meter's faceplate.



The screen fields and acceptable entries are as follows:

Phases Displayed: A; A and B; A, B, and C. This field determines which phases are displayed on the faceplate. For example, if you select A and B, only those two phases will be displayed on the faceplate.

Auto Scroll Display: Yes or No. This field enables/disables the scrolling of selected readings on the faceplate. If enabled, the readings scroll every 5 seconds.

Enable on Face Plate of Display: Check the boxes of the Readings you want displayed on the faceplate of the meter. You must select at least one reading.

Power Direction: View as Load or View as Generator

Flip Power Factor Sign: Yes or No

Current (I) Display Autoscale: On to apply scaling to the current display or Off (No decimal places)

Display Voltage in Secondary: Yes or No

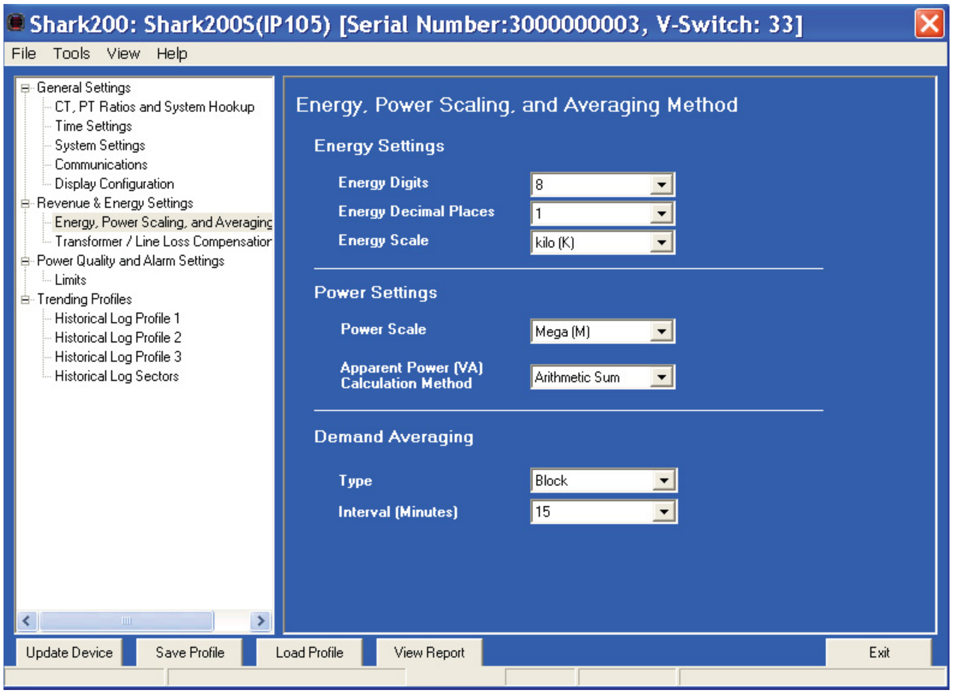
Load Bar Custom Configuration: To enter scaling for the Load Bar, click the Load Bar Custom Configuration checkbox. Fields display on the screen that allow you to enter a Scaling factor for the display. See the figure below.

Enter the scaling factor you want in the Current Scale field. This field is multiplied by the CT Multiplier (set in the CT, PT Ratios, and System Hookup screen) to arrive at the Primary Full Scale. Make sure you set the CT multiplier correctly.

Enable Fixed Scale for Voltage Display: To enter a scaling factor for the Voltage display, click the checkbox next to Enable Fixed Scale for Voltage Display. The screen changes - see the figure below.

Select the scaling you want to use from the pull-down menu. The options are: 0, 100.0kV, 10.00kV, or 0kV.

Energy, Power Scaling, and Averaging



The screen fields and acceptable entries are as follows:

Energy Settings

Energy Digits: 5; 6; 7; 8

Energy Decimal Places: 0 - 6

Energy Scale: unit; kilo (K); Mega (M)

Example: a reading for Digits: 8; Decimals: 3; Scale: K would be formatted as

00123.456k

Power Settings

Power Scale: Auto; unit; kilo (K); Mega (M)

Apparent Power (VA) Calculation Method: Arithmetic Sum; Vector Sum

Demand Averaging

Type: Block or Rolling

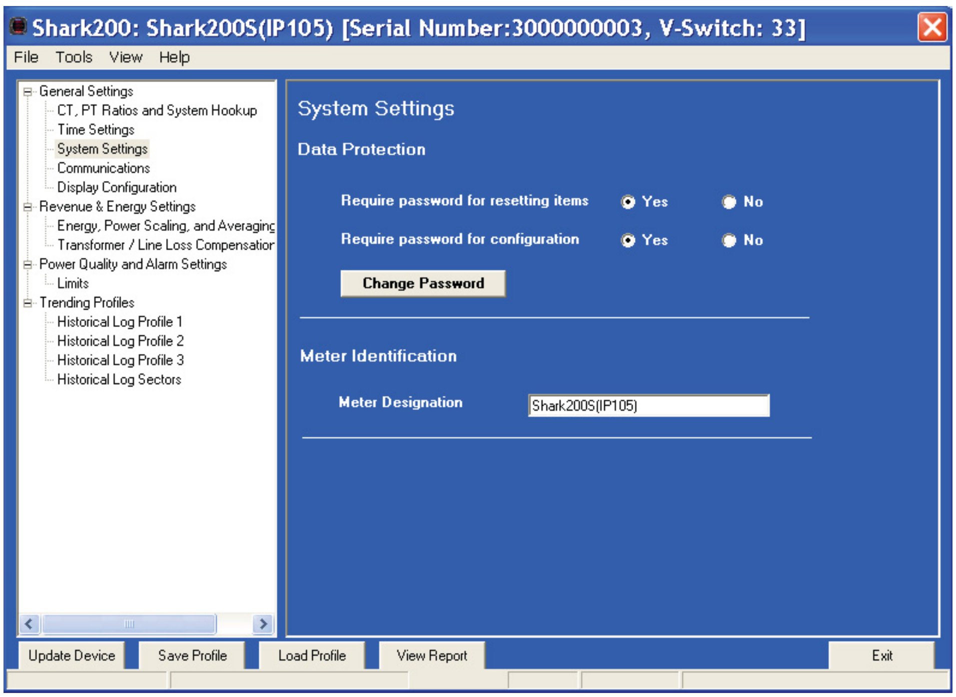
Interval (Block demand) or Sub-Interval (Rolling demand) in minutes: 5; 15; 30; 60

Number of Subintervals: 1; 2; 3; 4

Interval Window: This field is display only. It is the product of the values entered in the Sub-Interval and Number of Subintervals fields.

NOTE: You will only see the Number of Subintervals and Interval Window fields if you select Rolling Demand.

System Settings



From this screen, you can do the following:

- Enable or disable password for Reset (reset max/min Energy settings, Energy accumulators, and the individual logs) and/or Configuration (Device profile): click the radio button next to Yes or No.

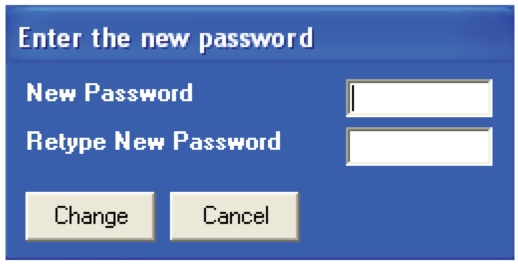
  NOTES:

  - If you enable a password for reset, you must also enable it for configuration.
  - The meter's default is password disabled.
  - Enabling Password protection prevents unauthorized tampering with devices. When a user attempts to make a change that is under Password protection,

Communicator EXT opens a screen asking for the password. If the correct password is not entered, the change does not take place.

IMPORTANT! You must set up a password before enabling Password protection. Click the **Change** button next to Change Password if you have not already set up a password.

- Change the Password: click the **Change** button. You will see the Enter the New Password screen, shown below.



1. Type in the new password (0 - 9999).

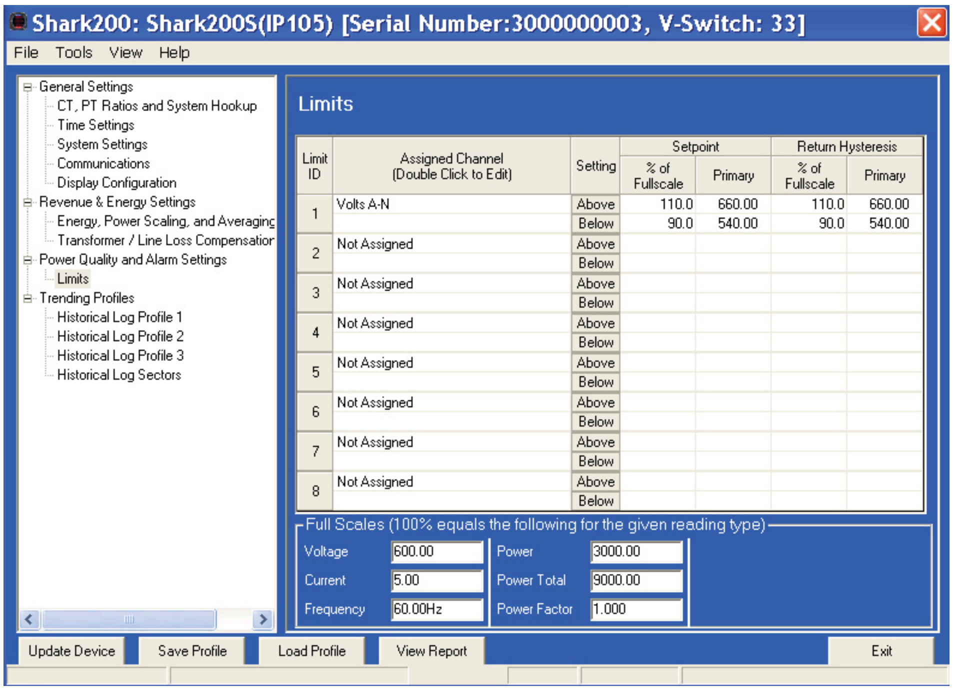
2. Retype the password.

3. Click **Change**. The new password is saved and the meter restarts.
   NOTE: If Password protection has already been enabled for configuration and you attempt to change the password, you will see the Enter Password screen after you click **Change**. Enter the old password and click **OK** to proceed with the password change.

- Change the Meter Identification: input a new meter label into the Meter Designation field.

Limits

Limits are transition points used to divide acceptable and unacceptable measurements. When a value goes above or below the limit an out-of-limit condition occurs. Once they are configured, you can view the out-of-Limits (or Alarm) conditions in the Limits log or Limits polling screen. You can also use Limits to trigger relays. See the *Communicator EXT User Manual* for details.

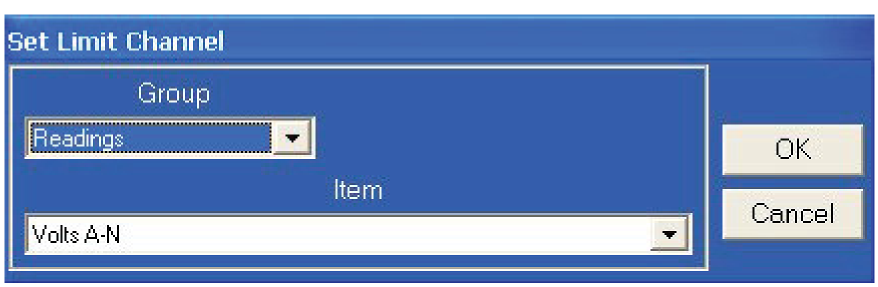


The current settings for Limits are shown in the screen. You can set and configure up to eight Limits for the Shark® 200S meter.

To set up a Limit:

1. Select a Limit by double-clicking on the Assigned Channel field.

2. You will see the screen shown below. Select a Group and an Item for the Limit.



3. Click **OK**.

To configure a Limit:

Double-click on the field to set the following values:

Above and Below Setpoint: % of Full Scale (the point at which the reading goes out of limit)

Examples:

100% of 120V Full Scale = 120V

90% of 120V Full Scale = 108V

Above and Below Return Hysteresis: the point at which the reading goes back within limit (see figure below)

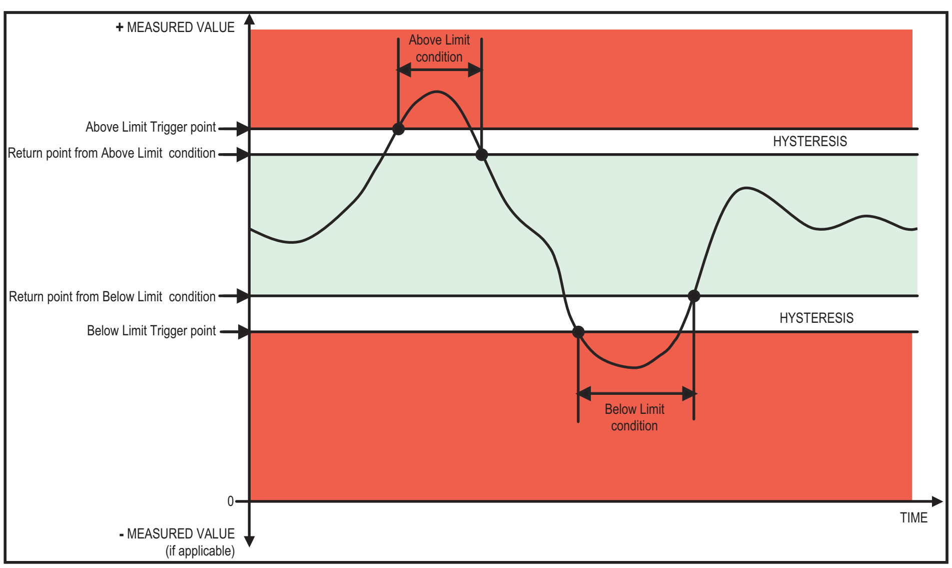
Examples:

Above Setpoint = 110%; Below Setpoint = 90%

(Out of Limit above 132V);(Out of Limit below 108V)

Above Return Hysteresis = 105%; Below Return Hysteresis = 95%

(Stay out of Limit until below 126V)(Stay out of Limit until above 114V)



Primary Fields: These fields are display only. They show what the setpoint and return hysteresis value are for each limit.

NOTES:

- If you are entering negative Limits, be aware that the negative value affects the way the above and below Limits function, since negative numbers are processed as signed values.

- If the Above Return Hysteresis is greater than the Above Setpoint, the Above Limit is Disabled; if the Below Return Hysteresis is less than the Below Setpoint, the Below Limit is Disabled. You may want to use this feature to disable either Above or Below Limit conditions for a reading.

IMPORTANT! When you finish making changes to the Device Profile, click **Update Device** to send the new Profile settings to the meter.

NOTE: Refer to Chapter 5 of the *Communicator EXT User Manual* for additional instructions on configuring the Shark® 200S meter settings, including Time Setting, Transformer and Line Loss Compensation, CT and PT Compensation, Secondary Voltage display, Symmetrical Components, Voltage and Current Unbalance, and scaling Primary readings for use with DNP.

6: Ethernet Configuration

6.1: Introduction

The Shark® 200S submeter offers an optional WiFi (Wireless) or RJ45 Ethernet connection. This option allows the submeter to be set up for use in a LAN (Local Area Network), using standard WiFi base stations. Configuration for these connections is easily accomplished through your PC using Telnet connections. Then you can access the submeter to perform meter functions directly through any computer on your LAN: the Shark® 200S meter does not need to be directly connected (wired) to these computers for it to be accessed. This chapter outlines the procedures for setting up the parameters for Ethernet communication.

- Host PC setup - Section 6.2
- Shark® 200S submeter setup - Section 6.3

6.2: Setting up the Host PC to Communicate with Shark® 200S Meter

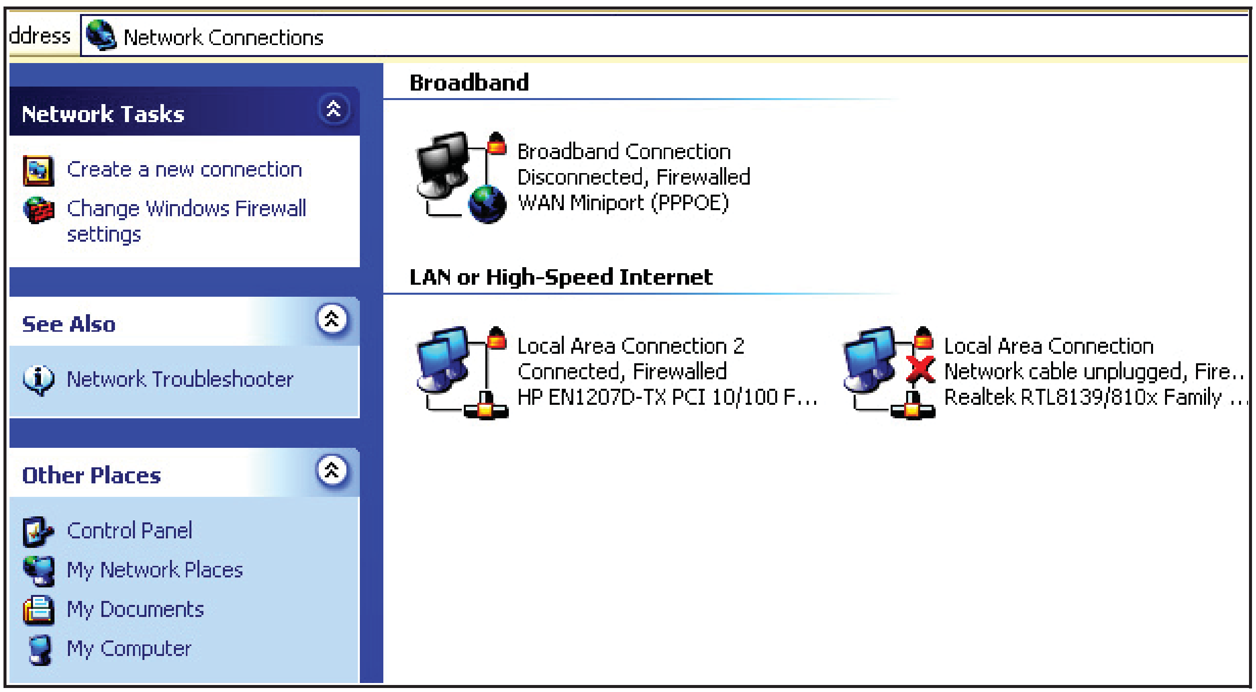
- Consult with your Network Administrator before performing these steps because some of the functions may be restricted to Administrator privileges.
- The Host PC could have multiple Ethernet Adapters (Network Cards) installed. Identify and configure the one that will be used for accessing the Shark® 200S meter.
- The PC's Ethernet Adapter must be set up for point-to-point communication when setting up for the Shark® 200S meter. The Factory Default IP parameters programmed in the Shark® 200S meter are:
  IP Address: 10.0.0.1
  Subnet Mask: 255.255.255.0
  See other parameters in Section 6.3.
- The factory default Ethernet mode is WLAN (WiFi) disabled. This means the meter can be accessed via the RJ45 jack and cable connection only!

If the settings are lost or unknown in the Shark® 200S meter, follow the procedure in Section 6.4 for restoring Factory Default parameters. Default settings are listed in Section 6.3.

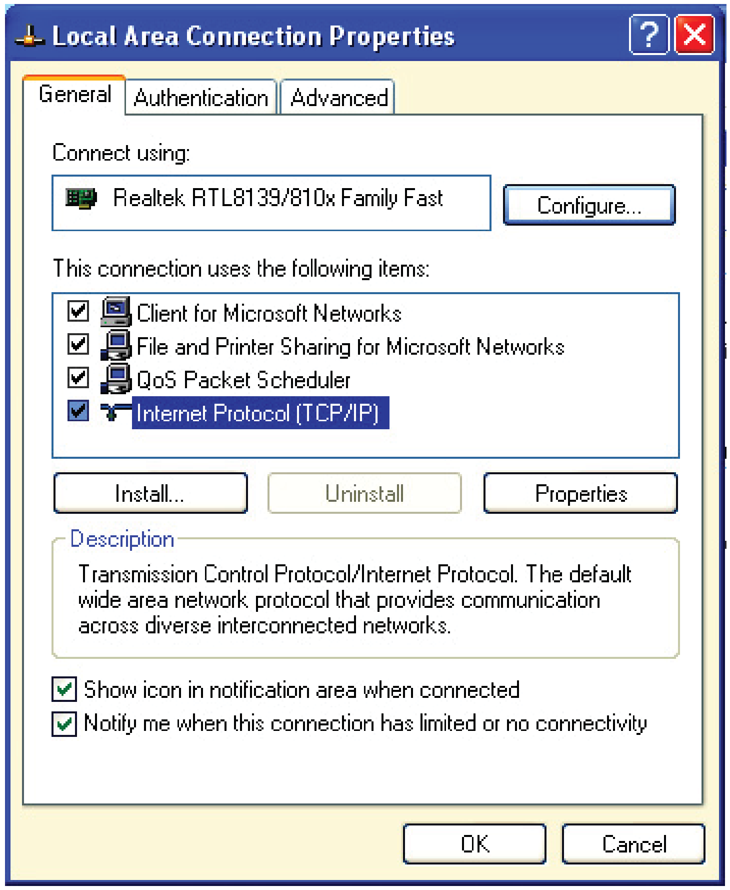
6.2.1: Configuring the Host PC's Ethernet Adapter Using Windows XP©

The following example shows the PC configuration settings that allow you to access the Shark® 200S meter in default mode. Use the same procedure when the settings are different than the default settings, but are also known to you.

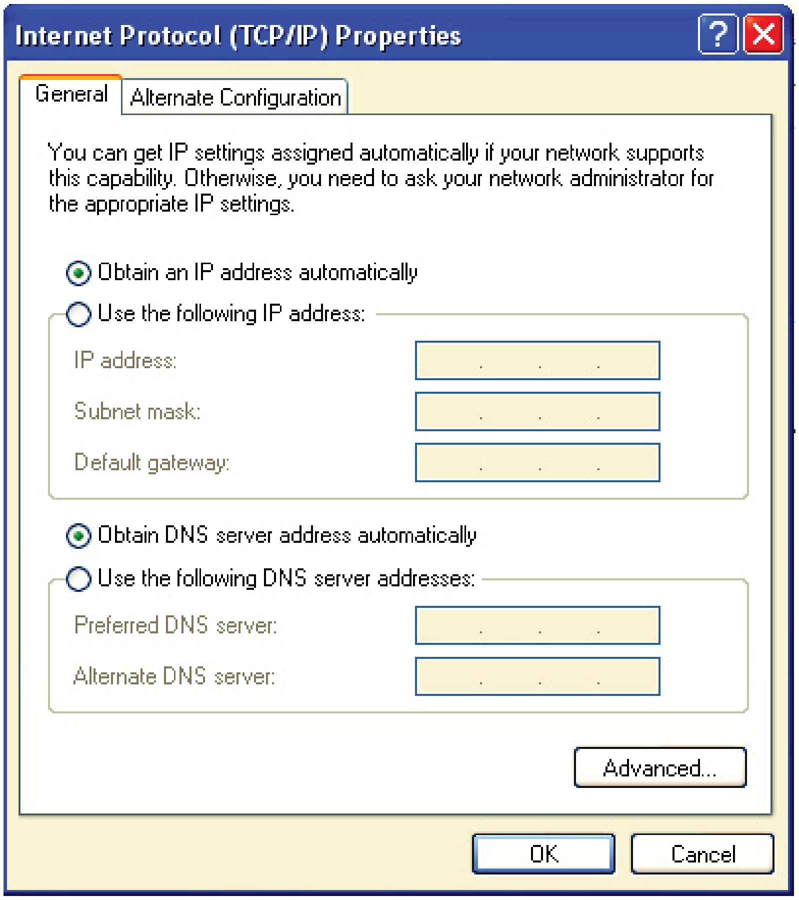
1. From the Start Menu, select **Settings>Network Connections** or **Control Panel>Network Connections**. You will see a screen like the one shown below.



2. Right click on the Local Area Network connection you will be using to connect to the Shark® 200S submeter, and select Properties from the pull-down menu. You will see the screen shown on the next page.



3. Select Internet Protocol [TCP/IP] from the middle of the screen and click the Properties button. You will see the screen shown on the next page.



4. Click the Use the Following IP Address radio button. The screen changes to allow you to enter the IP Address and Subnet Mask.

   a. Enter 10.0.0.2 in the IP Address field.

   b. Enter 255.255.255.0 in the Subnet Mask field.

3. Click the **OK** button.

4. You can now close the Local Area Connection Properties and Network Connection windows.

6.3: Setting up the Ethernet Module in the Shark® 200S Meter

Below are the Factory Default settings for the Shark® 200S meter's Ethernet Module. These are programmed into the meter before it is shipped out from the factory. Parameters indicated in bold letters (**1, 6**) may need to be altered to satisfy the local Ethernet configuration requirements. Other parameters (2, 3, 4) should not be altered.

Follow the procedure described in Section 6.4 if these Factory Default parameters need to be restored in the meter.

1) Network/IP Settings:
Network Mode…………Wired Only
IP Address ....….. 10.0.0.1
Default Gateway .... --- not set ---
Netmask .... …255.255.255.0
2) Serial & Mode Settings:
Protocol .... Modbus/RTU,Slave(s) attached
Serial Interface 57600,8,N,1,RS232,CH1
3) Modem/Configurable Pin Settings:
CP0..! Defaults (In) CP1..! GPIO (In) CP2..! GPIO (In)
CP3..! GPIO (In) CP4..! GPIO (In) CP5..! GPIO (In)
CP6..! GPIO (In) CP7..! GPIO (In) CP8..! GPIO (In)
CP9..! GPIO (In) CP10.! GPIO (In)
RTS Output .... Fixed High/Active
4) Advanced Modbus Protocol settings:
Slave Addr/Unit Id Source .. Modbus/TCP header
Modbus Serial Broadcasts ... Disabled (Id=0 auto-mapped to 1)
MB/TCP Exception Codes ..... Yes (return 00AH and 00BH)
Char, Message Timeout 00050msec, 05000msec
6) WLAN Settings:
WLAN .... Disabled, network:LTRX_IBSS
Topology……………. AdHoc, Country: US, Channel: 11
Security……………… none
TX Data rate………… 11 Mbps auto fallback
Power management….. not supported in ad hoc mode

- The Ethernet Module in the Shark® 200S meter can be locally or remotely configured using a Telnet connection over the network.

- The configuration parameters can be changed at any time and are retained when the meter is not powered up. After the configuration has been changed and saved, the Ethernet module performs a Reset.

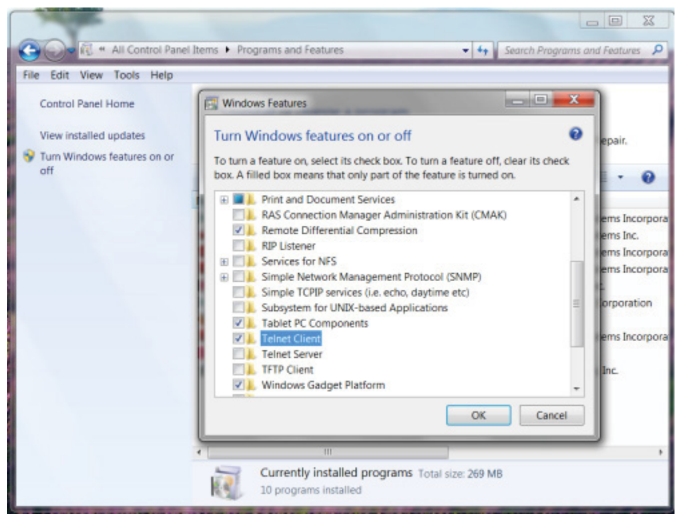
- Only one person at a time should be logged into the network port used for setting up the meter. This eliminates the possibility of several people trying to configure the Ethernet interface simultaneously.

6.3.1: Configuring the Ethernet Module in the Shark® 200S Meter using Windows XP© on the Host Computer

Establish a Telnet connection to port 9999:

NOTE: If your PC is running Windows 7, you need to enable Telnet before using it.

1. Open the Control Panel.
2. Select Programs and Features.
3. Select Turn Windows features on or off.
4. Check the box for Telnet Client.
5. Click OK. The Telnet client is now available.



1. From the Windows Start menu, click **Run** and type 'cmd'.

2. Click the **OK** button to bring up Windows's Command Prompt window.

3. In the Command Prompt window, type:

   telnet 10.0.0.1 9999 and press the **Enter** key.

   NOTE: Be sure to include a space between the IP address and 9999.

```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Administrator>telnet 10.0.0.1 9999
```

When the Telnet connection is established you will see a message similar to the example shown below.

```
Serial Number 5415404  MAC Address  00:20:4A:54:3C:2C
Software Version V01.2 (000719)
Press Enter to go into Setup Mode
```

4. To proceed to Setup Mode press **Enter** again. You will see a screen similar to the one shown below.

```
1) Network/IP Settings:
    Network Mode…………Wired Only
    IP Address ................….. 10.0.0.1
     Default Gateway ........... --- not set ---
     Netmask ................... …255.255.255.0
2) Serial & Mode Settings:
     Protocol .................. Modbus/RTU,Slave(s) attached
     Serial Interface ........... 57600,8,N,1,RS232,CH1
3) Modem/Configurable Pin Settings:
     CP0..! Defaults (In) CP1..! GPIO (In)     CP2..! GPIO (In)
     CP3..! GPIO (In)     CP4..! GPIO (In)     CP5..! GPIO (In)
     CP6..! GPIO (In)     CP7..! GPIO (In)     CP8..! GPIO (In)
     CP9..! GPIO (In)     CP10.! GPIO (In)
     RTS Output ................ Fixed High/Active
4) Advanced Modbus Protocol settings:
     Slave Addr/Unit Id Source .. Modbus/TCP header
     Modbus Serial Broadcasts ... Disabled (Id=0 auto-mapped to 1)
     MB/TCP Exception Codes ..... Yes (return 00AH and 00BH)
     Char, Message Timeout ...... 00050msec, 05000msec
6) WLAN Settings:
    WLAN ...................... Disabled, network:LTRX_IBSS
    Topology……………. AdHoc, Country: US, Channel: 11
    Security……………… none
    TX Data rate………… 11 Mbps auto fallback
    Power management….. not supported in ad hoc mode

D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..6) to change:
```

5. Type the number for the group of parameters you need to modify. After the group is selected, the individual parameters display for editing. Either:

- Enter a new parameter if a change is required.

- Press Enter to proceed to the next parameter without changing the current one.

Change Settings 1 and 6 ONLY! Settings 2, 3, and 4 MUST have the default values shown above.

6. Continue setting up parameters as needed. After finishing your modifications, make sure to press the "S" key on the keyboard. This will save the new values and perform a Reset in the Ethernet Module.

6.3.2: Example of Modifying Parameters in Groups 1 and 6

Follow the steps in 6.3.1 to enter Setup Mode.

- Network IP Settings Detail (1) (Set device with static IP Address.)
  Network Mode: 0=Wired only, 1=Wireless Only <0> ? 1
  IP Address <010> 192.<000> 168.<000> .<000> .<001>
  Set Gateway IP Address <N> ? Y
  Gateway IP Address : <192> .<168> .<000> .<001>
  Set Netmask <N for default> <Y> ? Y
  <255> .<255> .<255> .<000>
  Change telnet config password <N> ? N

- WLAN Settings Detail (6) (The settings shown are recommended by EIG for use with Shark® 200S submeter.)
  Topology: 0=Infrastructure, 1=Ad-Hoc <1> ? 0
  Network name <SSID> <LTRX_IBSS> ? EIG_SHARKS
  Security suite: 0=none, 1=WEP, 2=WPA, 3=WPA2/802.11i <0> ? 0
  TX Data rate: 0=fixed, 1=auto fallback <1> ? 1
  TX Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36, 7=54 Mbps <3> ? 7
  Enable power management <N> ? Y

  EIG recommends using 128-bit encryption for WiFi communication:
  In the WLAN Settings (6), set Security WEP (1), Authentication shared (1), WEP128 (1) and Change Key (Y).
  NOTE: Any key combination will work, but for added convenience a Passphrase-

generated WEP Key can be also be used: a Passphrase can be short and thus easy to remember. Numerous WEP Key providers offer this service free of charge on the Internet.

IMPORTANT NOTES:

- If you are opting for Infrastructure network topology, the Wireless Access Point device (e.g. Wireless Router) used should have IDENTICAL settings to the WLAN settings in the Shark® 200S meter. For programming details refer to the Wireless Access Point device User's Manual.
- When exiting Setup Mode don't forget to save changes by pressing "**S**."

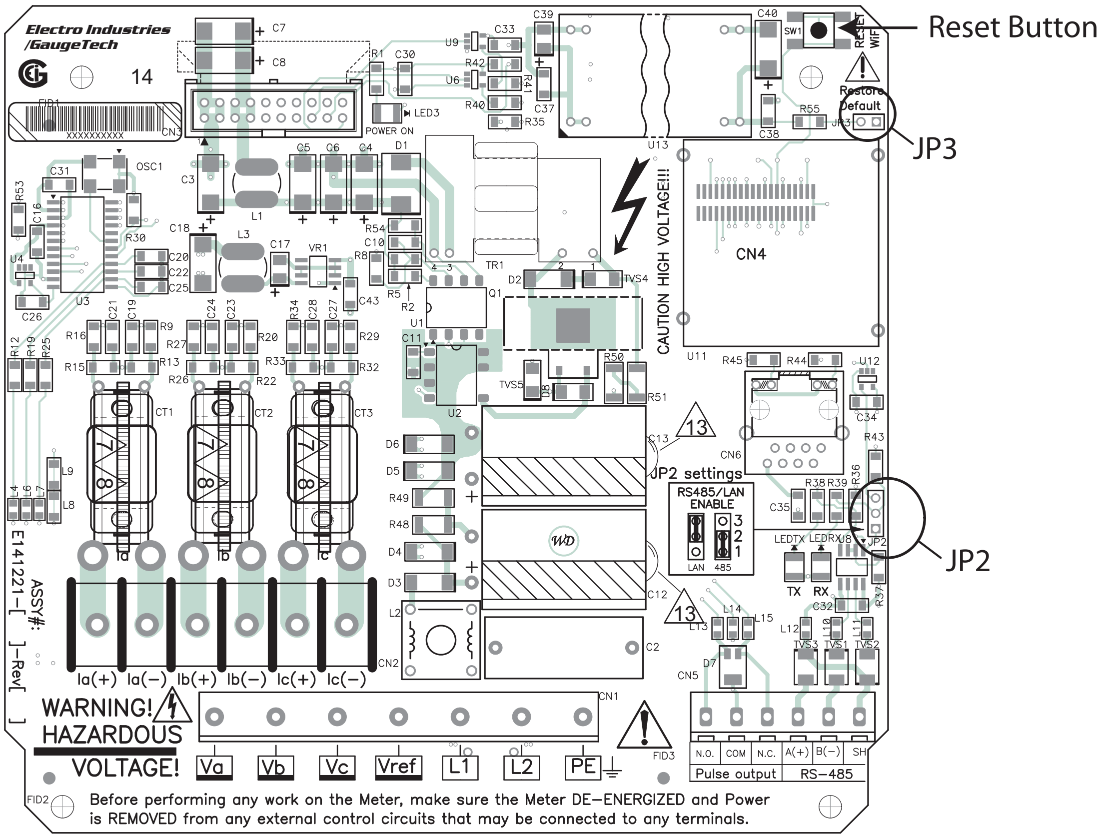
CAUTION! DO NOT PRESS 'D' as it will overwrite all changes and will save the default values.

6.4: Network Module Hardware Initialization

If you don't know your current Network Module settings, or if the settings are lost, you can use this method to initialize the hardware with known settings you can then work with.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

Main Board



1. Place a shorting block on JP3 and press the **Reset** button on the main board.
   NOTE: JP3 is located on the right hand side, upper corner of the main board. The shorting block can be "borrowed" from JP2, located at the middle, right hand side. See the figure shown above.

2. After you press the **Reset** button, move the jumper back to JP2.

7: Using the Submeter

7.1: Introduction

The Shark® 200S submeter can be configured and a variety of functions can be accomplished by using the Elements and the Buttons on the submeter face. This chapter reviews front panel navigation. See Appendix A for complete Navigation maps.

7.1.A: Understanding Submeter Face Elements

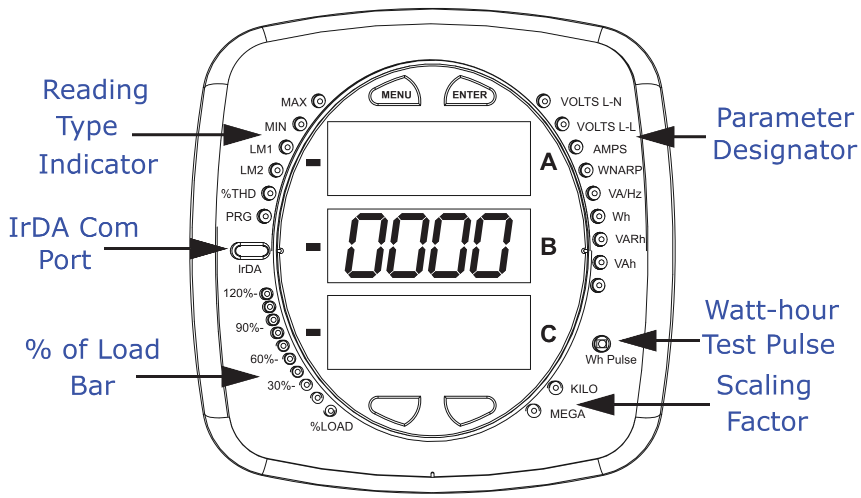


Figure 7.1: Faceplate with Elements

The meter face features the following elements:

- Reading Type Indicator: e.g., Max
- Parameter Designator: e.g., Volts L-N
- Watt-Hour Test Pulse: Energy pulse output to test accuracy
- Scaling Factor: Kilo or Mega multiplier of displayed readings
- % of Load Bar: Graphic Display of Amps as % of the Load (Refer to Section 7.3 for additional information.)
- IrDA Communication Port: Com 1 port for wireless communication

7.1.B: Understanding Submeter Face Buttons

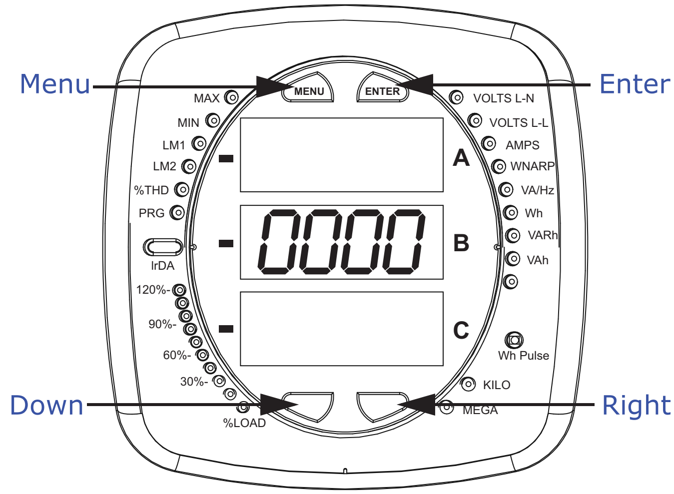


Figure 7.2: Faceplate with Buttons

The meter face has **Menu**, **Enter**, **Down** and **Right** buttons, which let you perform the following functions:

- View Meter Information
- Enter Display Modes
- Configure Parameters (may be Password Protected)
- Perform Resets (may be Password Protected)
- Perform LED Checks
- Change Settings
- View Parameter Values
- Scroll Parameter Values
- View Limit States

7.2: Using the Front Panel

You can access four modes using the Shark® 200S submeter's front panel buttons:

- Operating mode (Default)
- Reset mode
- Configuration mode
- Information mode - Information mode displays a sequence of screens that show model information, such as Frequency, Amps, V-Switch, etc.

Use the **Menu**, **Enter**, **Down** and **Right** buttons to navigate through each mode and its related screens.

NOTES:

- See Appendix A for the complete display mode Navigation maps.
- The meter can also be configured using software; see Chapter 5 and the *Communicator EXT User Manual* for instructions.

7.2.1: Understanding Startup and Default Displays

Upon Power Up, the meter displays a sequence of screens:

- Lamp Test screen where all LEDs are lit
- Lamp Test screen where all digits are lit
- Firmware screen showing build number
- Error screen (if an error exists)

After startup, if auto-scrolling is enabled, the Shark® 200S meter scrolls the parameter readings on the right side of the front panel. The Kilo or Mega LED lights, showing the scale for the Wh, VARh and VAh readings. Figure 7.3 shows an example of a Wh reading.

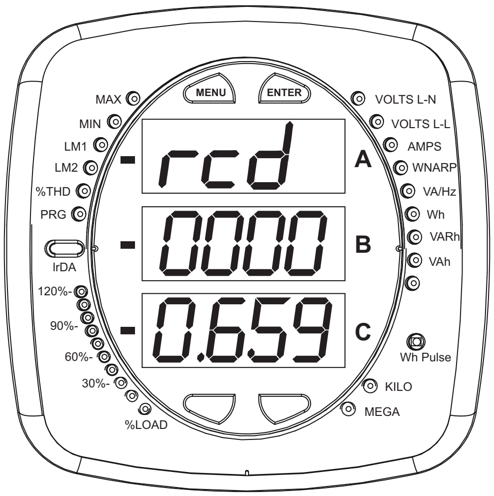


Figure 7.3: Display Showing Watt-hr Reading

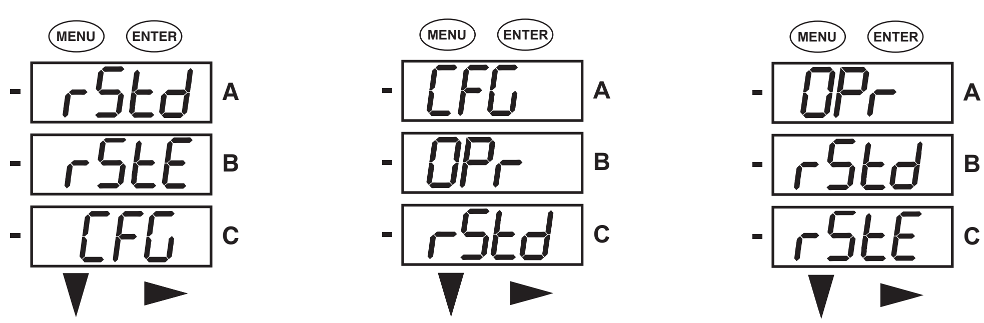
The Shark® 200S meter continues to provide scrolling readings until one of the buttons on the front panel is pressed, causing the meter to enter one of the other Modes.

7.2.2: Using the Main Menu

1. Press the **Menu** button. The Main Menu screen appears.

- The Reset: Demand mode (rStd) appears in the A window. Use the Down button to scroll, causing the Reset: Energy (rStE), Configuration (CFG), Operating (OPr), and Information (InFo) modes to move to the A window.

- The mode that is currently flashing in the A window is the “Active” mode, which means it is the mode that can be configured.



For example: Press Down Twice -   CFG moves to A window. Press Down Twice - OPr moves to A   window.

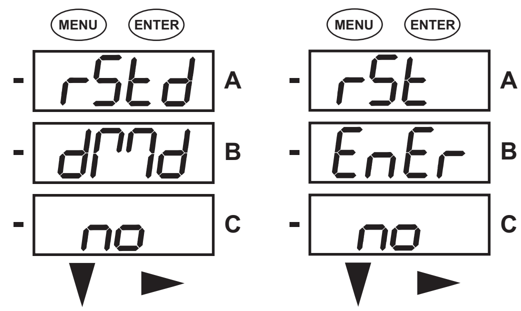
2. Press the **Enter** button from the Main Menu to view the Parameters screen for the mode that is currently active.

7.2.3: Using Reset Mode

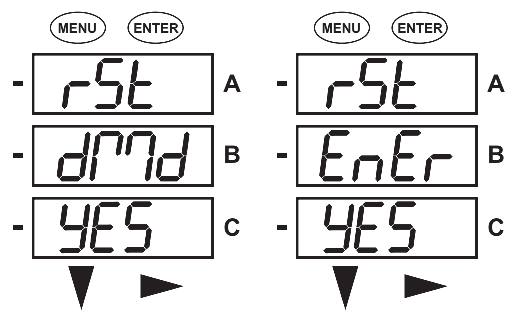
Reset mode has two options:

- Reset: Demand (rStd): resets the Max and Min values.
- Reset: Energy (rStE): resets the energy accumulator fields.

1. Press the Enter button while either rStd or rStE is in the A window. The Reset Demand No or Reset Energy No screen appears.



   - If you press the **Enter** button again, the Main Menu appears, with the next mode in the A window. (The **Down** button does not affect this screen.)
   - If you press the **Right** button, the Reset Demand YES or Reset Energy YES screen appears. Press **Enter** to perform a reset.



NOTE: If Password protection is enabled for reset, you must enter the four digit password before you can reset the meter (see Chapter 5 for information on Password protection). To enter a password, follow the instructions in Section 7.2.4.

CAUTION! Reset Demand YES resets **all** Max and Min values.

2. Once you have performed a reset, the screen displays either "rSt dMd donE" or "rSt EnEr donE"and then resumes auto-scrolling parameters.

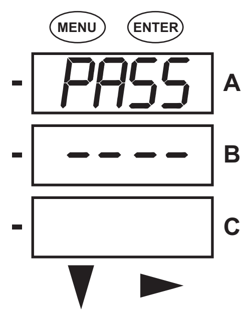
7.2.4: Entering a Password

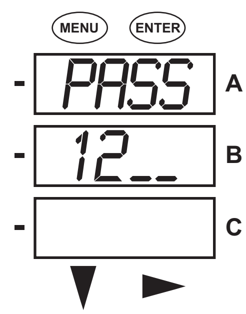
If Password protection has been enabled in the software for reset and/or configuration (see Chapter 5 for more information), a screen appears requesting a password when you try to reset the meter and/or configure settings through the front panel.

- PASS appears in the A window and 4 dashes appear in the B window. The leftmost dash is flashing.

1. Press the **Down** button to scroll numbers from 0 to 9 for the flashing dash. When the correct number appears for that dash, use the **Right** button to move to the next dash.

Example: The left screen, below, shows four dashes. The right screen shows the display after the first two digits of the password have been entered.



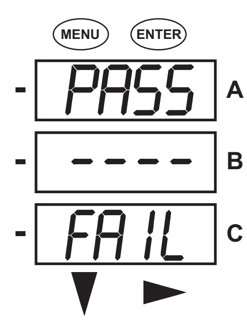


2. When all 4 digits of the password have been selected, press the **Enter** button.

- If you are in Reset Mode and you enter the correct password, “rSt dMd donE” or “rSt EnEr donE”appears and the screen resumes auto-scrolling parameters.

- If you are in Configuration Mode and you enter the correct password, the display returns to the screen that required a password.

- If you enter an incorrect password, “PASS ---- FAIL” appears and:
  - The previous screen is re-displayed, if you are in Reset Mode.
  - The previous Operating mode screen is re-displayed, if you are in Configuration mode.



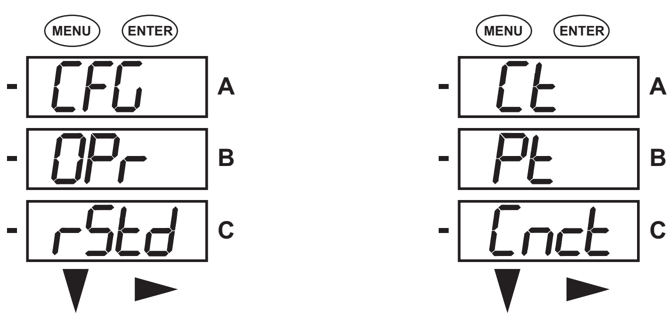
7.2.5: Using Configuration Mode

Configuration mode follows Reset: Energy on the Main Menu.

To access Configuration mode

1. Press the **Menu** button while the meter is auto-scrolling parameters.
2. Press the **Down** button until the Configuration Mode option (CFG) is in the A window.
3. Press the **Enter** button. The Configuration Parameters screen appears.
4. Press the **Down** button to scroll through the configuration parameters: Scroll (SCrL), CT, PT, Connection (Cnct) and Port. The parameter currently 'Active," i.e., configurable, flashes in the A window.
5. Press the **Enter** button to access the Setting screen for the currently active parameter.

NOTE: You can use the **Enter** button to scroll through all of the Configuration parameters and their Setting screens, in order.



Press **Enter** when CFG is in A window - Parameter screen appears -

Press **Down**- Press **Enter** when

Parameter you want is in A window

6. The parameter screen appears, showing the current settings. To change the settings:
   - Use either the **Down** button or the **Right** button to select an option.

- To enter a number value, use the **Down** button to select the number value for a digit and the **Right** button to move to the next digit.

NOTE: When you try to change the current setting and Password protection is enabled for the meter, the Password screen appears. See Section 7.2.4 for instructions on entering a password.

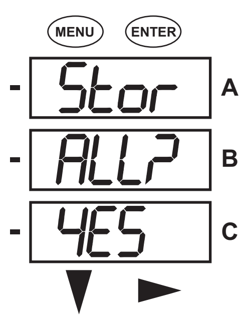
7. Once you have entered the new setting, press the **Menu** button twice.

8. The Store ALL YES screen appears. You can either:

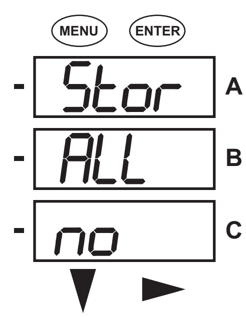
- Press the **Enter** button to save the new setting.

- Press the **Right** button to access the Store ALL no screen; then press the **Enter** button to cancel the Save.

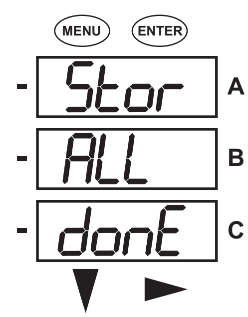
9. If you have saved the settings, the Store ALL done screen appears and the meter resets.



Press the **Enter** button to save the settings. Press the **Right** button for Stor All no screen.



Press the **Enter** button to Cancel the Save.



The settings have been saved.

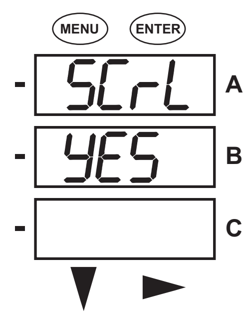
7.2.5.1: Configuring the Scroll Feature

When in Auto Scroll mode, the meter performs a scrolling display, showing each parameter for 7 seconds, with a 1 second pause between parameters. The parameters that the meter displays have been selected through software (refer to the *Communicator EXT User Manual* for instructions).

To enable or disable Auto-scrolling:

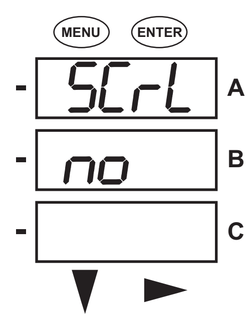
1. Press the **Enter** button when SCrl is in the A window. The Scroll YES screen appears.

2. Press either the **Right** or **Down** button if you want to access the Scroll no screen. To return to the Scroll YES screen, press either button.



3. Press the **Enter** button on either the Scroll YES screen (to enable auto-scrolling) or the Scroll no screen (to disable auto-scrolling).

4. The CT- n screen appears (this is the next Configuration mode parameter).



NOTES:

- To exit the screen without changing scrolling options, press the **Menu** button.

- To return to the Main Menu screen, press the **Menu** button twice.

- To return to the scrolling (or non-scrolling) parameters display, press the **Menu** button three times.

7.2.5.2: Configuring CT Setting

The CT Setting has three parts: Ct-n (numerator), Ct-d (denominator), and Ct-S (scaling).

1. Press the **Enter** button when Ct is in the A window. The Ct-n screen appears. You can either:

   - Change the value for the CT numerator.

   - Access one of the other CT screens by pressing the **Enter** button: press **Enter** once to access the Ct-d screen, twice to access the Ct-S screen.

     NOTE: The Ct-d screen is preset to a 5 Amp or 1 Amp value at the factory and cannot be changed.

   a. To change the value for the CT numerator:

      From the Ct-n screen:

      - Use the Down button to select the number value for a digit.

      - Use the Right button to move to the next digit.

   b. To change the value for CT scaling

      From the Ct-S screen:

      Use the **Right** button or the **Down** button to choose the scaling you want. The Ct-S setting can be 1, 10, or 100.

NOTE: If you are prompted to enter a password, refer to Section 7.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. The Store ALL YES screen appears. Press **Enter** to save the new CT setting.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200 and the Ct-S value for 1.

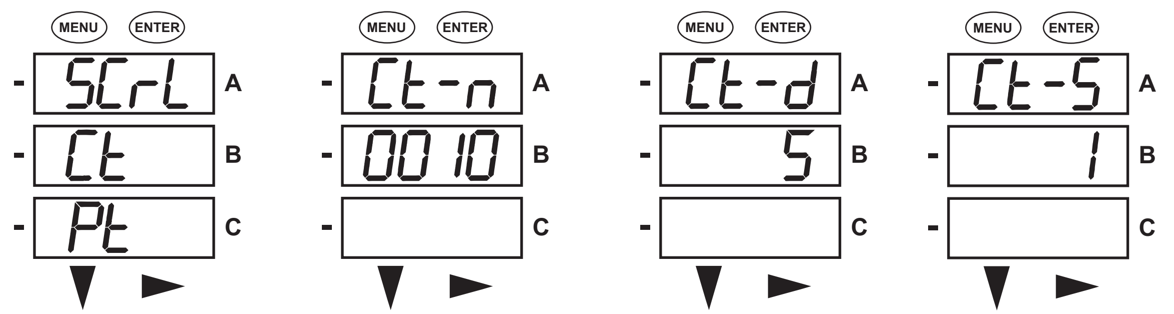
800/5 Amps: Set the Ct-n value for 800 and the Ct-S value for 1.

2,000/5 Amps: Set the Ct-n value for 2000 and the Ct-S value for 1.

10,000/5 Amps: Set the Ct-n value for 1000 and the Ct-S value for 10.

NOTES:

- The value for Amps is a product of the Ct-n value and the Ct-S value.
- Ct-n and Ct-S are dictated by primary current; Ct-d is secondary current.



Press **Enter** | Use buttons to set Ct-n | Ct-d cannot be changed | Use buttons to select scaling

7.2.5.3: Configuring PT Setting

The PT Setting has three parts: Pt-n (numerator), Pt-d (denominator), and Pt-S (scaling).

1. Press the **Enter** button when Pt is in the A window. The PT-n screen appears. You can either:

   - Change the value for the PT numerator.
   - Access one of the other PT screens by pressing the **Enter** button: press **Enter** once to access the Pt-d screen, twice to access the Pt-S screen.

   a. To change the value for the PT numerator or denominator:

   From the Pt-n or Pt-d screen:

   - Use the **Down** button to select the number value for a digit.
   - Use the **Right** button to move to the next digit.

b. To change the value for the PT scaling:

From the Pt-S screen:

Use the **Right** button or the **Down** button to choose the scaling you want. The Pt-S setting can be 1, 10, 100, or 1000.

NOTE: If you are prompted to enter a password, refer to Section 7.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. The STOR ALL YES screen appears. Press **Enter** to save the new PT setting.

Example PT Settings:

277/277 Volts: Pt-n value is 277, Pt-d value is 277, Pt-S value is 1.

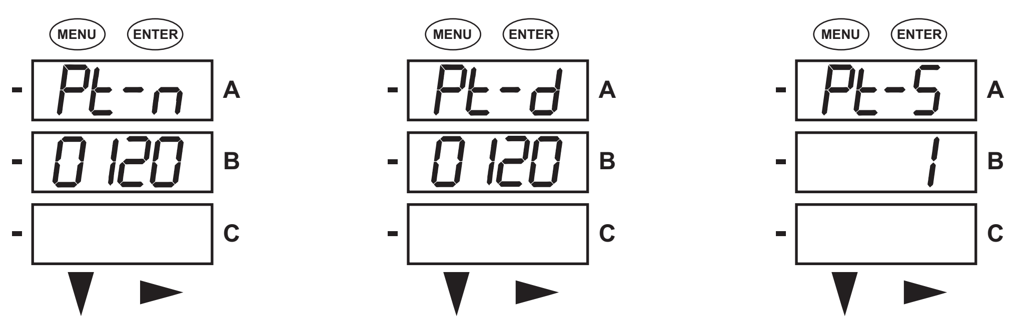
14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.

138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.

345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.

345,000/69 Volts: Pt-n value is 345, Pt-d value is 69, Pt-S value is 1000.

NOTE: Pt-n and Pt-S are dictated by primary voltage; Pt-d is secondary voltage.



Use buttons to set Pt-n   Use buttons to set Pt-d   Use buttons to select scaling

7.2.5.4: Configuring Connection Setting

1. Press the **Enter** button when Cnct is in the A window. The Cnct screen appears.

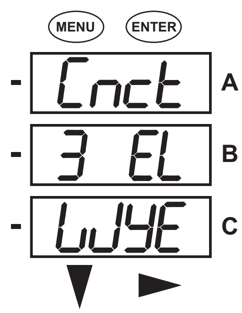
2. Press the **Right** button or **Down** button to select a configuration. The choices are:

   - 3 Element Wye (3 EL WYE)
   - 2.5 Element Wye (2.5EL WYE)
   - 2 CT Delta (2 Ct dEL)

NOTE: If you are prompted to enter a password, refer to Section 7.2.4 for instructions on doing so.

3. When you have made your selection, press the **Menu** button twice.

4. The STOR ALL YES screen appears. Press **Enter** to save the setting.



Use buttons to select configuration

7.2.5.5: Configuring Communication Port Setting

Port configuration consists of: Address (a three digit number), Baud Rate (9600; 19200; 38400; or 57600), and Protocol (DNP 3.0; Modbus RTU; or Modbus ASCII).

1. Press the **Enter** button when POrt is in the A window. The Adr (address) screen appears. You can either:

   - Enter the address.
   - Access one of the other Port screens by pressing the **Enter** button: press **Enter** once to access the bAUd screen (Baud Rate), twice to access the Prot screen (Protocol).

a. To enter the Address

From the Adr screen:

- Use the **Down** button to select the number value for a digit.
- Use the **Right** button to move to the next digit.

b. To select the Baud Rate:

From the bAUd screen:

Use the **Right** button or the **Down** button to select the setting you want.

c. To select the Protocol:

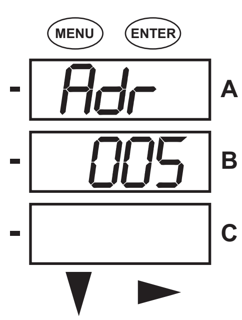
From the Prot screen:

Press the **Right** button or the **Down** button to select the setting you want.

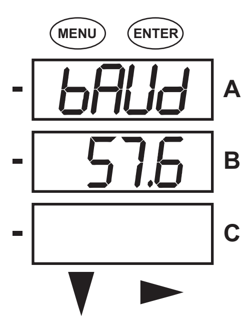
NOTE: If you are prompted to enter a password, refer to Section 7.2.4 for instructions on doing so.

2. When you have finished making your selections, press the **Menu** button twice.

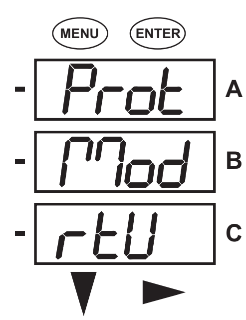
3. The STOR ALL YES screen appears. Press **Enter** to save the settings.



Use buttons to enter Address



Use buttons to select Baud Rate



Use buttons to select Protocol

7.2.6: Using Operating Mode

Operating mode is the Shark® 200S submeter's default mode, that is, the standard front panel display. After starting up, the meter automatically scrolls through the parameter screens, if scrolling is enabled. Each parameter is shown for 7 seconds, with a 1 second pause between parameters. Scrolling is suspended for 3 minutes after any button is pressed.

1. Press the **Down** button to scroll all the parameters in Operating mode. The currently "Active," i.e., displayed, parameter has the Indicator light next to it, on the right face of the meter.

2. Press the **Right** button to view additional readings for that parameter. The table below shows possible readings for Operating mode. Sheet 2 in Appendix A shows the Operating mode Navigation map.

NOTE: Readings or groups of readings are skipped if not applicable to the meter type or hookup, or if they are disabled in the programmable settings.

OPERATING MODE PARAMETER READINGS

POSSIBLE READINGS

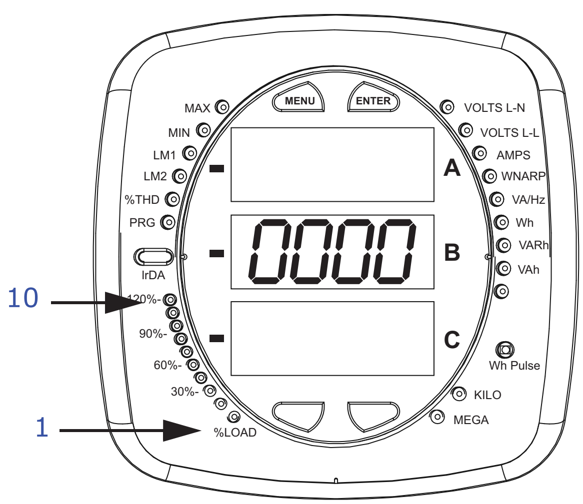
VOLTS L-N	VOLTS_LN	VOLTS_LN_ MAX	VOLTS_LN_ MIN		VOLTS_LN_ THD
VOLTS L-L	VOLTS_LL	VOLTS_LL_ MAX	VOLTS_LL_ MIN		
AMPS	AMPS	AMPS_NEU TRAL	AMPS_MAX	AMPS_MIN	AMPS_THD
W/VAR/PF	W_VAR_PF	W_VAR_PF _MAX_POS	W_VAR_PF _MIN_POS	W_VAR_PF _MIN_NEG	
VA/Hz	VA_FREQ	VA_FREQ_ MAX	VA_FREQ_ MIN		
Wh	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT	
VARh	KVARH_PO S	KVARH_NE G	KVARH_NE T	KVARH_TO T	
VAh	KVAH				

7.3: Understanding the % of Load Bar

The 10-segment LED bar graph at the bottom left of the Shark® 200S meter's front panel provides a graphic representation of Amps. The segments light according to the load, as shown in the table below.

When the Load is over 120% of Full Load, all segments flash "On" (1.5 secs) and "Off" (0.5 secs).

Segments	Load >= % Full Load
none	no load
1	1%
1-2	15%
1-3	30%
1-4	45%
1-5	60%
1-6	72%
1-7	84%
1-8	96%
1-9	108%
1-10	120%
All Blink	>120%



7.4: Performing Watt-Hour Accuracy Testing (Verification)

To be certified for revenue metering, power providers and utility companies must verify that the billing energy meter performs to the stated accuracy. To confirm the meter's performance and calibration, power providers use field test standards to ensure that the unit's energy measurements are correct. Since the Shark® 200S sub-meter is a traceable revenue meter, it contains a utility grade test pulse that can be used to gate an accuracy standard. This is an essential feature required of all billing grade meters.

- Refer to Figure 7.5 for an example of how this process works.
- Refer to Table 7.1 for the Wh/Pulse constants for accuracy testing.

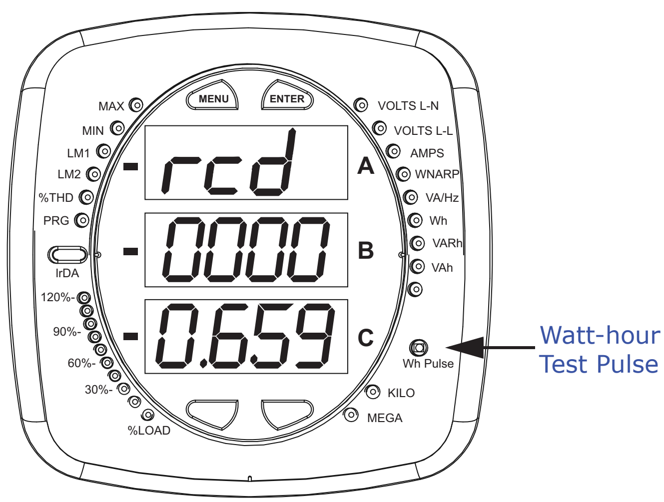


Figure 7.4: Watt-hour Test Pulse

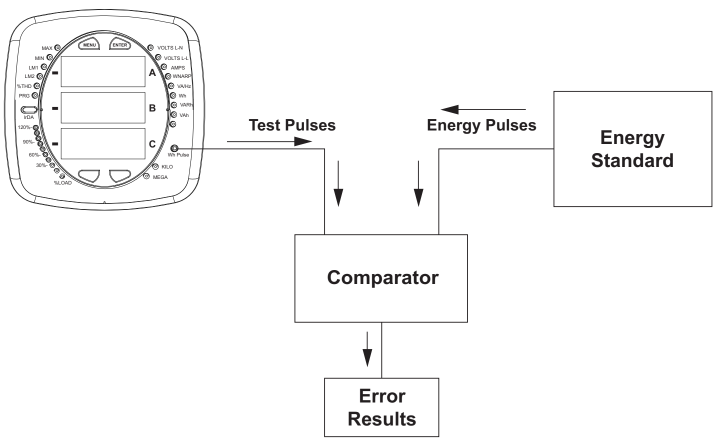


Figure 7.5: Using the Watt-hour Test Pulse

Input Voltage Level	Class 10 Models	Class 2 Models
Below 150V	0.500017776	0.1000035555
Above 150V	2.000071103	0.400014221

Table 7.1: Infrared & KYZ Pulse Constants for Accuracy Testing - Kh Watt-hour per pulse

NOTES:

- Minimum pulse width is 90 milliseconds.
- Refer to Chapter 2, Section 2.2, for Wh Pulse specifications.

A: Shark® 200S Meter Navigation Maps

A.1: Introduction

You can configure the Shark® 200S meter and perform related tasks using the buttons on the meter face. Chapter 7 contains a description of the buttons on the meter face and instructions for programming the meter using them. The meter can also be programmed using software (see Chapter 5 and the *Communicator EXT User Manual*).

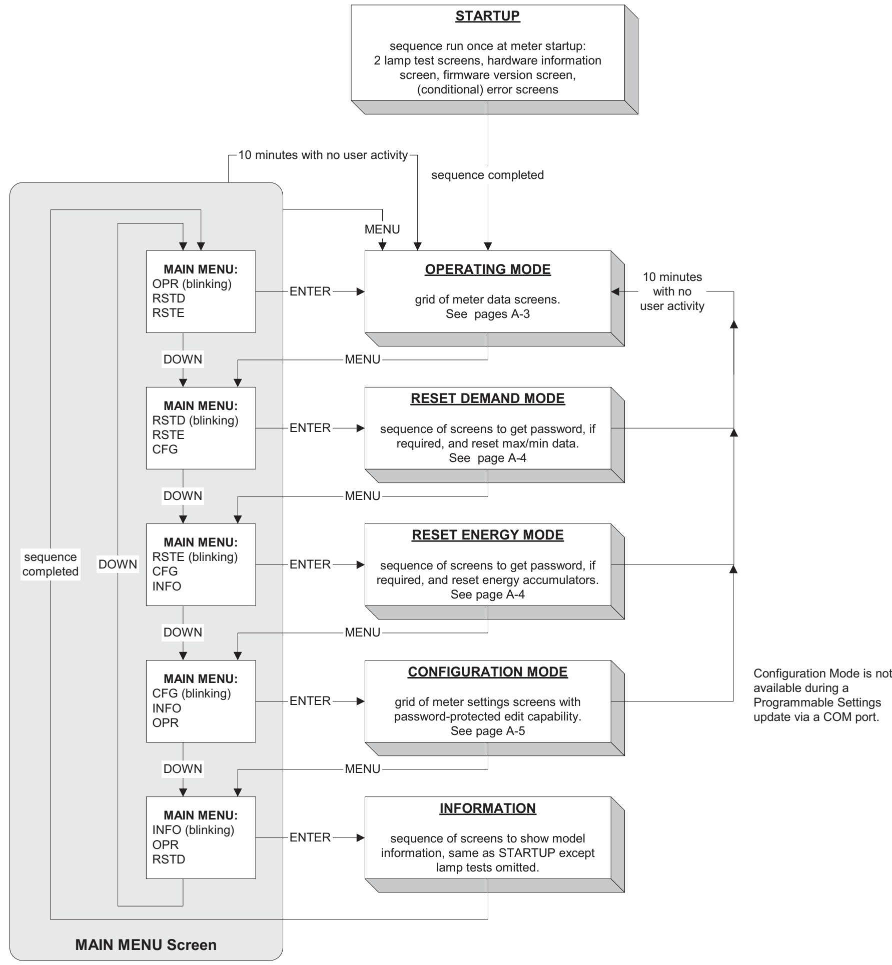
A.2: Navigation Maps (Sheets 1 to 4)

The Shark® 200S meter's Navigation maps begin on the next page. The maps show in detail how to move from one screen to another and from one display mode to another using the buttons on the face of the meter. All display modes automatically return to Operating mode after 10 minutes with no user activity.

Shark® 200S meter Navigation map titles

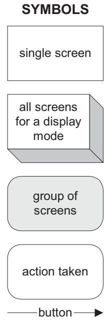
- Main Menu Screens (Sheet 1)
- Operating mode screens (Sheet 2)
- Reset mode screens (Sheet 3)
- Configuration mode screens (Sheet 4)

Main Menu Screens (Sheet 1)



MAIN MENU screen scrolls through 4 choices, showing 3 at a time. The top choice is always the "active" one, which is indicated by blinking the legend.

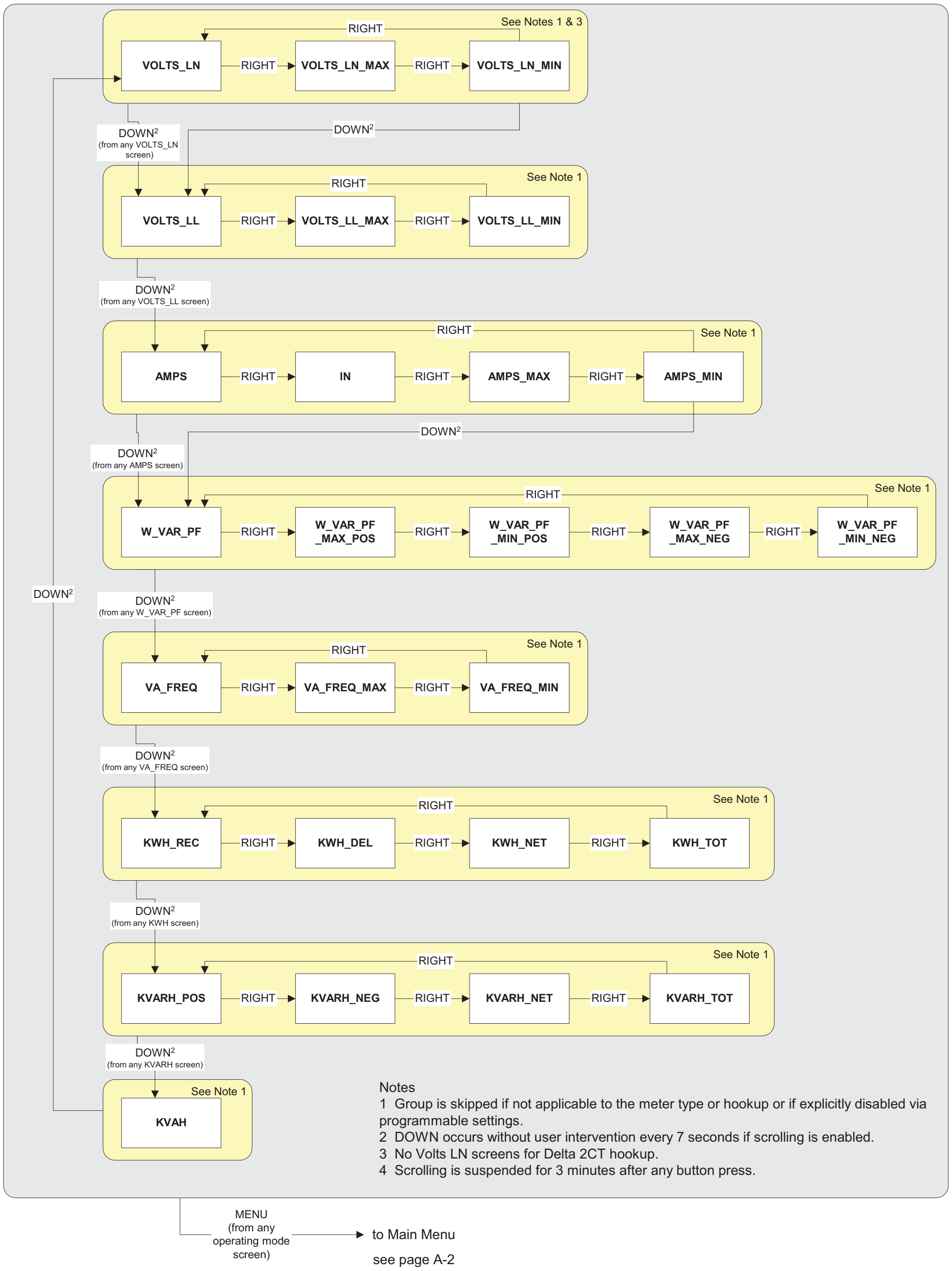
SYMBOLS



BUTTONS

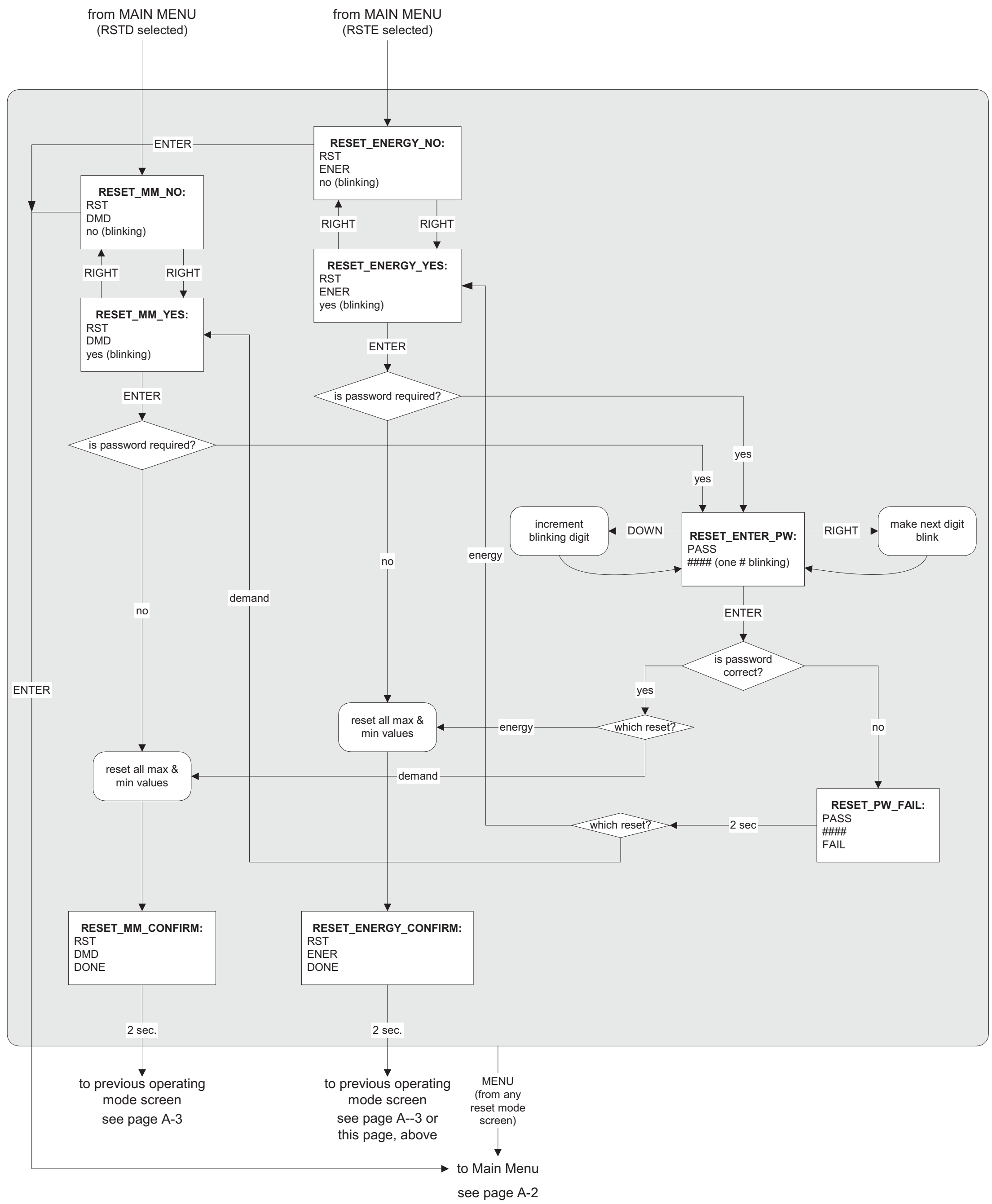
MENU	Returns to previous menu from any screen in any mode
ENTER	Indicates acceptance of the current screen and advances to the next one
DOWN, RIGHT	Navigation and edit buttons
Navigation:	No digits or legends are blinking. On a menu, down advances to the next menu selection, right does nothing. In a grid of screens, down advances to the next row, right advances to the next column. Rows, columns, and menus all navigate circularly.
Editing:	A digit or legend is blinking to indicate that it is eligible for change. When a digit is blinking, down increases the digit value, right moves to the next digit. When a legend is blinking, either button advances to the next choice legend.

Operating Mode Screens (Sheet 2)

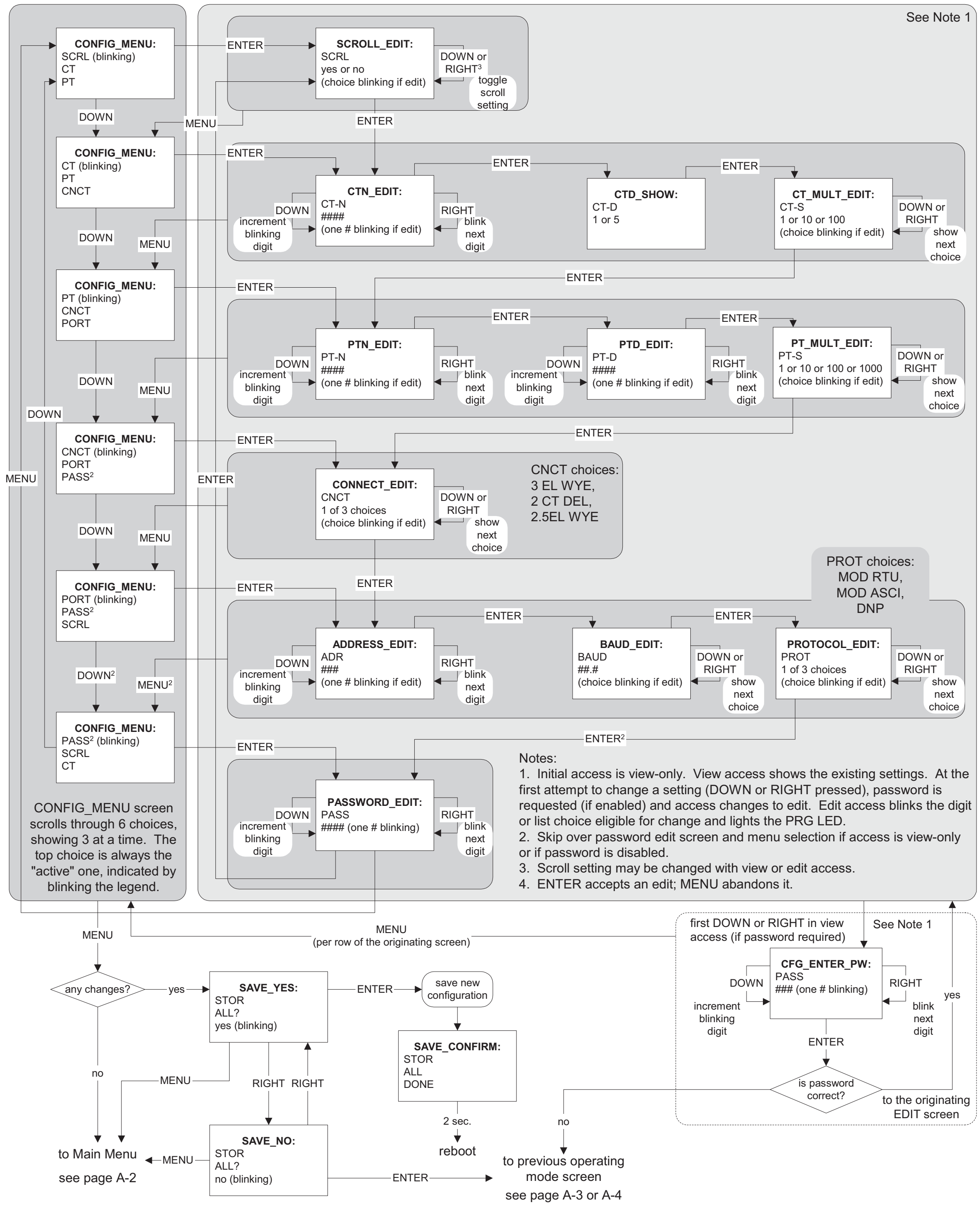


Notes
1 Group is skipped if not applicable to the meter type or hookup or if explicitly disabled via programmable settings.
2 DOWN occurs without user intervention every 7 seconds if scrolling is enabled.
3 No Volts LN screens for Delta 2CT hookup.
4 Scrolling is suspended for 3 minutes after any button press.

Reset Mode Screens (Sheet 3)



Configuration Mode Screens (Sheet 4)



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B: Modbus Map and Retrieving Logs

B.1: Introduction

The Modbus Map for the Shark® 200S meter gives details and information about the possible readings of the meter and its programming. The Shark® 200S meter can be programmed using the buttons on the face of the meter (Chapter 7), or by using software (Chapter 5).

B.2: Modbus Register Map Sections

The Shark® 200S meter's Modbus Register map includes the following sections:

Fixed Data Section, Registers 1- 47, details the meter's Fixed Information.

Meter Data Section, Registers 1000 - 12031, details the meter's Readings, including Primary Readings, Energy Block, Demand Block, Phase Angle Block, Status Block, Minimum and Maximum in Regular and Time Stamp Blocks, and Accumulators. Operating mode readings are described in Section 7.2.6.

Commands Section, Registers 20000 - 26011, details the meter's Resets Block, Programming Block, Other Commands Block and Encryption Block.

Programmable Settings Section, Registers 30000 - 33575, details all the setups you can program to configure your meter.

Secondary Readings Section, Registers 40001 - 40100, details the meter's Secondary Readings.

Log Retrieval Section, Registers 49997 - 51127, details log and retrieval. See Section B.5 for instructions on retrieving logs.

B.3: Data Formats

ASCII:	ASCII characters packed 2 per register in high, low order and without any termination characters
SINT16/UINT16:	16-bit signed/unsigned integer

SINT32/UINT32:	32-bit signed/unsigned integer spanning 2 registers - the lower-addressed register is the high order half
FLOAT:	32-bit IEEE floating point number spanning 2 registers - the lower-addressed register is the high order half (i.e., contains the exponent)

B.4: Floating Point Values

Floating Point Values are represented in the following format:

Register	0																1															
Byte	0								1								0								1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
sign		exponent								mantissa																						

The formula to interpret a Floating Point Value is:

$-1^{sign} \times 2^{\,exponent-127} \times 1.mantissa = 0x0C4E11DB9$

$-1^{sign} \times 2^{\,137-127} \times 1\cdot 1000010001110110111001$

$-1 \times 2^{10} \times 1.75871956$

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B9v							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	1	0	0	1
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m																
	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m																
sign		exponent								mantissa																						
1		0x089 + 137								0b011000010001110110111001																						

Formula Explanation:

C4E11DB9 (hex)	11000100 11100001 00011101 10111001 (binary)

The sign of the mantissa (and therefore the number) is 1, which represents a negative value.

The Exponent is 10001001 (binary) or 137 decimal.

The Exponent is a value in excess 127. So, the Exponent value is 10.

The Mantissa is 11000010001110110111001 binary.

With the implied leading 1, the Mantissa is (1).611DB9 (hex).

The Floating Point Representation is therefore -1.75871956 times 2 to the 10.

Decimal equivalent: -1800.929

NOTES:

- Exponent = the whole number before the decimal point.
- Mantissa = the positive fraction after the decimal point.

B.5: Retrieving Logs Using the Shark® 200S Meter's Modbus Map

This section describes the log interface system of the Shark® 200S meter from a programming point of view. It is intended for programmers implementing independent drivers for log retrieval from the meter. It describes the meaning of the meter's Modbus Registers related to log retrieval and conversion, and details the procedure for retrieving a log's records.

NOTES:

- All references assume the use of Modbus function codes 0x03, 0x06, and 0x10, where each register is a 2 byte MSB (Most Significant Byte) word, except where otherwise noted.
- The carat symbol (^) notation is used to indicate mathematical "power." For example, 2^8 means 28; which is 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2, which equals 256.

B.5.1: Data Formats

Time stamp: Stores a date from 2000 to 2099. Time stamp has a Minimum resolution of 1 second.

Byte	0	1	2	3	4	5
Value	Year	Month	Day	Hour	Minute	Second
Range	0-99 (+2000)	1-12	1-31	0-23	0-59	0-59
Mask	0x7F	0x0F	0x1F	0x1F	0x3F	0x3F

The high bits of each time stamp byte are used as flags to record meter state information at the time of the time stamp. These bits should be masked out, unless needed.

B.5.2: Shark® 200S Meter Logs

The Shark® 200S meter has 5 logs: System Event, Alarm (Limits), and 3 Historical logs. Each log is described below.

1. **System Event (0)**: The System Event log is used to store events which happen in, and to, the meter. Events include Startup, Reset Commands, Log Retrievals, etc. The System Event Log Record takes 20 bytes, 14 bytes of which are available when the log is retrieved.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Value	timestamp						Group	Event	Mod	Chan	Param1	Param2	Param3	Param4

NOTE: The complete Systems Events table is shown in Section B.5.5, step 1, on page B-19.

2. **Alarm Log (1):** The Alarm Log records the states of the 8 Limits programmed in the meter.

- Whenever a limit goes out (above or below), a record is stored with the value that caused the limit to go out.
- Whenever a limit returns within limit, a record is stored with the "most out of limit" value for that limit while it was out of limit.

The Alarm Log Record uses 16 bytes, 10 bytes of which are available when the log is retrieved.

Byte	0	1	2	3	4	5	6	7	8	9
Value	timestamp						direction	limit#	Value%	

The limit # byte is broken into a type and an ID.

Bit	0	1	2	3	4	5	6	7
Value	type	0	0	0	0	Limit ID		

3. **Historical Log 1 (2)**: The Historical Log records the values of its assigned registers at the programmed interval.

NOTE: See Section B.5.3, Number 1, for details on programming and interpreting the log.

Byte	0	1	2	3	4	5	6	-	-	N
Value	timestamp						values . . .			

4. **Historical Log 2 (3)**: Same as Historical Log 1.

5. **Historical Log 3 (4)**: Same as Historical Log 1.

B.5.3: Block Definitions

This section describes the Modbus Registers involved in retrieving and interpreting a Shark® 200S Meter Log. Other sections refer to certain 'values' contained in this section. See the corresponding value in this section for details.

NOTES:

- "Register" is the Modbus Register Address in 0-based Hexadecimal notation. To convert it to 1-based decimal notation, convert from hex16 to decimal10 and add 1. For example: 0x03E7 = 1000.
- "Size" is the number of Modbus Registers (2 byte) in a block of data.

Historical Log Programmable Settings:

The Historical Logs are programmed using a list of Modbus Registers that will be copied into the Historical Log record. In other words, Historical Log uses a direct copy of the Modbus Registers to control what is recorded at the time of record capture.

To supplement this, the programmable settings for the Historical Logs contain a list of descriptors, which group registers into items. Each item descriptor lists the data type of the item, and the number of bytes for that item. By combining these two lists, the Historical Log record can be interpreted.

For example: Registers 0x03E7 and 0x03E8 are programmed to be recorded by the historical log. The matching descriptor gives the data type as float, and the size as 4 bytes. These registers program the log to record "Primary Readings Volts A-N."

Historical Log Blocks:

Start Register:	0x7917 (Historical Log 1)
	0x79D7 (Historical Log 2)
	0x7A97 (Historical Log 3)
Block Size:	192 registers per log (384 bytes)

The Historical Log programmable settings are comprised of 3 blocks, one for each log. Each is identical to the others, so only Historical Log 1 is described here. All register addresses in this section are given as the Historical Log 1 address (0x7917).

Each Historical Log Block is composed of 3 sections: The header, the list of registers to log, and the list of item descriptors.

Header:

Registers:	0x7917 - 0x7918
Size:	2 registers

Byte	0	1	2	3
Value	# Registers	# Sectors		Interval

- # Registers: The number of registers to log in the record. The size of the record in memory is [12 + (# Registers x 2)]. The size during normal log retrieval is [6 + (# Registers x 2)]. If this value is 0, the log is disabled. Valid values are {0-117}.

- # Sectors: The number of Flash Sectors allocated to this log. Each sector is 64kb, minus a sector header of 20 bytes. 15 sectors are available for allocation between Historical Logs 1, 2, and 3. The sum of all Historical Logs may be less than 15. If this value is 0, the log is disabled. Valid values are {0-15}.

- Interval: The interval at which the Historical Log's Records are captured. This value is an enumeration:

0x01	1 minute
0x02	3 minute
0x04	5 minute
0x08	10 minute
0x10	15 minute
0x20	30 minute
0x40	60 minute

<u>Register List:</u>

Registers:	0x7919 - 0x798D
Size:	1 register per list item, 117 list items

The Register List controls what Modbus Registers are recorded in each record of the Historical Log. Since many items, such as Voltage, Energy, etc., take up more than 1 register, multiple registers need to be listed to record those items.

For example: Registers 0x03E7 and 0x03E8 are programmed to be recorded by the historical log. These registers program the log to record "Primary Readings Volts A-N."

- Each unused register item should be set to 0x0000 or 0xFFFF to indicate that it should be ignored.

- The actual size of the record, and the number of items in the register list which are used, is determined by the # registers in the header.

- Each register item is the Modbus Address in the range of 0x0000 to 0xFFFF.

<u>Item Descriptor List:</u>

Registers:	0x798E - 0x79C8
Size:	1 byte per item, 117 bytes (59 registers)

While the Register List describes what to log, the Item Descriptor List describes how to interpret that information. Each descriptor describes a group of register items, and what they mean.

Each descriptor is composed of 2 parts:

- Type: The data type of this descriptor, such as signed integer, IEEE floating point, etc. This is the high nibble of the descriptor byte, with a value in the range of 0-14. If this value is 0xFF, the descriptor should be ignored.

0	ASCII: An ASCII string, or byte array
1	Bitmap: A collection of bit flags
2	Signed Integer: A 2's Complement integer
3	Float: An IEEE floating point
4	Energy: Special Signed Integer, where the value is adjusted by the energy settings in the meter's Programmable Settings.
5	Unsigned Integer
6	Signed Integer 0.1 scale: Special Signed Integer, where the value is divided by 10 to give a 0.1 scale.
7-14	Unused
15	Disabled: used as end list marker.

- Size: The size in bytes of the item described. This number is used to determine the pairing of descriptors with register items.

For example: If the first descriptor is 4 bytes, and the second descriptor is 2 bytes, then the first 2 register items belong to the 1st descriptor, and the 3rd register item belongs to the 2nd descriptor.

NOTE: As can be seen from the example, above, there is not a 1-to-1 relation between the register list and the descriptor list. A single descriptor may refer to multiple register items.

Register Items	Descriptors
0x03C7/ 0x03C8	Float, 4 byte
0x1234	Signed Int, 2 byte

NOTE: The sum of all descriptor sizes must equal the number of bytes in the data portion of the Historical Log record.

Log Status Block:

The Log Status Block describes the current status of the log in question. There is one header block for each of the logs. Each log's header has the following base address:

Log	Base Address
Alarms:	0xC737
System:	0xC747
Historical 1:	0xC757
Historical 2:	0xC767
Historical 3:	0xC777

Bytes	Value	Type	Range	# Bytes
0-3	Max Records	UINT32	0 to 4,294,967,294	4
4-7	Number of Records Used	UINT32	1 to 4,294,967,294	4

8-9	Record Size in Bytes	UINT16	4 to 250	2
10-11	Log Availability	UINT16		2
12-17	Timestamp, First Record	TSTAMP	1Jan2000 - 31Dec2099	6
18-23	Timestamp, Last Record	TSTAMP	1Jan2000 - 31Dec2099	6
24-31	Reserved			8

- Max Records: The maximum number of records the log can hold given the record size, and sector allocation. The data type is an unsigned integer from 0 - 2^32.

- Records Used: The number of records stored in the log. This number will equal the Max Records when the log has filled. This value will be set to 1 when the log is reset. The data type is an unsigned integer from 1 - 2^32.

NOTE: The first record in every log before it has rolled over is a "dummy" record, filled with all 0xFF's. When the log is filled and rolls over, this record is overwritten.

- Record Size: The number of bytes in this record, including the timestamp. The data type is an unsigned integer in the range of 14 - 242.

- Log Availability: A flag indicating if the log is available for retrieval, or if it is in use by another port.

0	Log Available for retrieval
1	In use by COM1 (IrDA)
2	In use by COM2 (RS485)
0xFFFF	Log Not Available - the log cannot be retrieved.

This indicates that the log is disabled.

NOTE: To query the port by which you are currently connected, use the Port ID register:

Register:	0x1193
Size:	1 register

Description: A value from 1-4, which enumerates the port that the requestor is currently connected on.

NOTES:

- When Log Retrieval is engaged, the Log Availability value will be set to the port that engaged the log. The Log Availability value will stay the same until either the log has been disengaged, or 5 minutes have passed with no activity. It will then reset to 0 (available).
- Each log can only be retrieved by one port at a time.
- Only one log at a time can be retrieved.

- First Timestamp: Timestamp of the oldest record.
- Last Timestamp: Timestamp of the newest record.

Log Retrieval Block:

The Log Retrieval Block is the main interface for retrieving logs. It is comprised of 2 parts: the header and the window. The header is used to program the particular data the meter presents when a log window is requested. The window is a sliding block of data that can be used to access any record in the specified log.

Session Com Port: The Shark® 200S meter's Com Port which is currently retrieving logs. Only one Com Port can retrieve logs at any one time.

Registers:	0xC34E - 0xC34E
Size:	1 register
0	No Session Active
1	COM1 (IrDA)
2	COM2 (RS-485)

To get the current Com Port, see the NOTE on querying the port, on the previous page.

Log Retrieval Header:

The Log Retrieval Header is used to program the log to be retrieved, the record(s) of that log to be accessed, and other settings concerning the log retrieval.

Registers:	0xC34F - 0xC350
Size:	2 registers

Bytes	Value	Type	Format	Description	# Bytes
0-1	Log Number, Enable, Scope	UINT16	nnnnnnnn esssssss	nnnnnnnn - log to retrieve, e - retrieval session enable sssssss - retrieval mode	2
2-3	Records per Window, Number of Repeats	UINT16	wwwwwwww nnnnnnnn	wwwww-www - records per window, nnnnnnnn - repeat count	2

- Log Number: The log to be retrieved. Write this value to set which log is being retrieved.

0	System Events
1	Alarms
2	Historical Log 1
3	Historical Log 2
4	Historical Log 3

- Enable: This value sets if a log retrieval session is engaged (locked for retrieval) or disengaged (unlocked, read for another to engage). Write this value with 1(enable) to begin log retrieval. Write this value with 0(disable) to end log retrieval.

0	Disable
1	Enable

- Scope: Sets the amount of data to be retrieved for each record. The default should be 0 (normal).

0	Normal
1	Timestamp Only
2	Image

  - Normal [0]: The default record. Contains a 6-byte timestamp at the beginning, then N data bytes for the record data.
  - Timestamp [1]: The record only contains the 6-byte timestamp. This is most useful to determine a range of available data for non-interval based logs, such as Alarms and System Events.
  - Image [2]: The full record, as it is stored in memory. Contains a 2-byte checksum, 4-byte sequence number, 6-byte timestamp, and then N data bytes for the record data.

- Records Per Window: The number of records that fit evenly into a window. This value is set-able, as less than a full window may be used. This number tells the retrieving program how many records to expect to find in the window.

(RecPerWindow x RecSize) = #bytes used in the window.

This value should be ((123 x 2) \ recSize), rounded down.

For example, with a record size of 30, the RecPerWindow = ((123 x 2) \ 30) = 8.2 ~= 8

- Number of Repeats: Specifies the number of repeats to use for the Modbus Function Code 0x23 (35). Since the meter must pre-build the response to each log window request, this value must be set once, and each request must use the same repeat count. Upon reading the last register in the specified window, the record index will increment by the number of repeats, if auto-increment is enabled. Section B.5.4.2 has additional information on Function Code 0x23.

0	Disables auto-increment
1	No Repeat count, each request will only get 1 window.
2-8	2-8 windows returned for each Function Code 0x23 request.

Bytes	Value	Type	Format	Description	# Bytes
0-3	Offset of First Record in Window	UINT32	ssssssss nnnnnnnn nnnnnnnn nnnnnnnn	ssssssss - window status nn…nn - 24-bit record index number.	4
4-249	Log Retrieve Window	UINT16			246

Log Retrieval Window Block:

The Log Retrieval Window block is used to program the data you want to retrieve from the log. It also provides the interface used to retrieve that data.

Registers:	0xC351 - 0xC3CD
Size:	125 registers

- Window Status: The status of the current window. Since the time to prepare a window may exceed an acceptable modbus delay (1 second), this acts as a state flag, signifying when the window is ready for retrieval. When this value indicates that the window is not ready, the data in the window should be ignored. Window Status is Read-only, any writes are ignored.

0	Window is Ready
0xFF	Window is Not Ready

- Record Number: The record number of the first record in the data window. Setting this value controls which records will be available in the data window.
    - When the log is engaged, the first (oldest) record is "latched." This means that record number 0 will always point to the oldest record at the time of latching, until the log is disengaged (unlocked).
    - To retrieve the entire log using auto-increment, set this value to 0, and retrieve the window repeatedly, until all records have been retrieved.

    NOTES:

        - When auto-increment is enabled, this value will automatically increment so that the window will "page" through the records, increasing by RecordsPerWindow each time that the last register in the window is read.
        - When auto-increment is not enabled, this value must be written-to manually, for each window to be retrieved.
- Log Retrieval Data Window: The actual data of the records, arranged according to the above settings.

B.5.4: Log Retrieval

Log Retrieval is accomplished in 3 basic steps:

1. Engage the log.

2. Retrieve each of the records.

3. Disengage the log.

B.5.4.1: Auto-Increment

In EIG's traditional Modbus retrieval system, you write the index of the block of data to retrieve, then read that data from a buffer (window). To improve the speed of retrieval, the index can be automatically incremented each time the buffer is read.

In the Shark® 200S meter, when the last register in the data window is read, the record index is incremented by the Records per Window.

B.5.4.2: Modbus Function Code 0x23

QUERY

Field Name	Example (Hex)
Slave Address	01
Function	23
Starting Address Hi	C3
Starting Address Lo	51
# Points Hi	00
# Points Lo	7D
Repeat Count	04

RESPONSE

Field Name	Example (Hex)
Slave Address	01
Function	23
# Bytes Hi	03
# Bytes Lo	E0
Data	...

Function Code 0x23 is a user defined Modbus function code, which has a format similar to Function Code 0x03, except for the inclusion of a "repeat count." The repeat count (RC) is used to indicate that the same N registers should be read RC number of times. (See the Number of Repeats bullet on page B-14.)

NOTES:

- By itself this feature would not provide any advantage, as the same data will be returned RC times. However, when used with auto-incrementing, this function condenses up to 8 requests into 1 request, which decreases communication time, as fewer transactions are being made.
- Keep in mind that the contents of the response data is the block of data you requested, repeated N times. For example, when retrieving log windows, you normally request both the window index, and the window data. This means that the first couple of bytes of every repeated block will contain the index of that window.
- In the Shark® 200S meter repeat counts are limited to 8 times for Modbus RTU, and 4 times for Modbus ASCII.

The response for Function Code 0x23 is the same as for Function Code 0x03, with the data blocks in sequence.

IMPORTANT! Before using Function Code 0x23, always check to see if the current connection supports it. Some relay devices do not support user defined function codes; if that is the case, the message will stall. Other devices don't support 8 repeat counts.

B.5.4.3: Log Retrieval Procedure

The following procedure documents how to retrieve a single log from the oldest record to the newest record, using the "normal" record type (see **Scope**). All logs are retrieved using the same method. See Section B.5.4.4 for a Log Retrieval example.

NOTES:

- This example uses auto-increment.
- In this example, Function Code 0x23 is not used.
- You will find referenced topics in Section B.5.3. Block Definitions.
- Modbus Register numbers are listed in brackets.

1. Engage the Log:

a. Read the Log Status Block.

i.. Read the contents of the specific logs' status block [0xC737+, 16 reg] (see Log Headers).

ii. Store the # of Records Used, the Record Size, and the Log Availability.

iii. If the Log Availability is not 0, stop Log Retrieval; this log is not available at this time. If Log Availability is 0, proceed to step 1b (Engage the log).

This step is done to ensure that the log is available for retrieval, as well as retrieving information for later use.

b. Engage the log: write log to engage to Log Number, 1 to Enable, and the desired mode to Scope (default 0 (Normal)) [0xC34F, 1 reg]. This is best done as a single-register write.

This step will latch the first (oldest) record to index 0, and lock the log so that only this port can retrieve the log, until it is disengaged.

c. Verify the log is engaged: read the contents of the specific logs' status block [0xC737+, 16 reg] again to see if the log is engaged for the current port (see Log Availability). If the Log is not engaged for the current port, repeat step 1b (Engage the log).

d. Write the retrieval information.

i. Compute the number of records per window, as follows:

RecordsPerWindow = (246 \ RecordSize)

- If using 0x23, set the repeat count to 2-8. Otherwise, set it to 1.
- Since we are starting from the beginning for retrieval, the first record index is 0.

ii. Write the Records per window, the Number of repeats (1), and Record Index (0) [0xC350, 3 reg].

This step tells the Shark® 200S meter what data to return in the window.

2. Retrieve the records:

a. Read the record index and window: read the record index, and the data window [0xC351, 125 reg].

- If the meter Returns a Slave Busy Exception, repeat the request.
- If the Window Status is 0xFF, repeat the request.
- If the Window Status is 0, go to step 2b (Verify record index).

NOTES:

- We read the index and window in 1 request to minimize communication time, and to ensure that the record index matches the data in the data window returned.
- Space in the window after the last specified record (RecordSize x Record-PerWindow) is padded with 0xFF, and can be safely discarded.

b. Verify that the record index incremented by Records Per Window. The record index of the retrieved window is the index of the first record in the window. This value will increase by Records Per Window each time the window is read, so it should be 0, N, N x 2, N x 3 . . . for each window retrieved.

- If the record index matches the expected record index, go to step 2c (Compute next expected record index).
- If the record index does not match the expected record index, then go to step 1d (Write the retrieval information), where the record index will be the same as the expected record index. This will tell the Shark® 200S meter to repeat the records you were expecting.

c. Compute next Expected Record Index.

- If there are no remaining records after the current record window, go to step 3 (Disengage the log).

- Compute the next expected record index by adding Records Per Window, to the current expected record index. If this value is greater than the number of records, re-size the window so it only contains the remaining records and go to step 1d (Write the retrieval information), where the Records Per Window will be the same as the remaining records.

3. Disengage the log: write the Log Number (of log being disengaged) to the Log Index and 0 to the Enable bit [0xC34F, 1 reg].

B.5.4.4: Log Retrieval Example

The following example illustrates a log retrieval session. The example makes the following assumptions:

- Log Retrieved is Historical Log 1 (Log Index 2).
- Auto-Incrementing is used.
- Function Code 0x23 is not used (Repeat Count of 1).
- The Log contains Volts-AN, Volts-BN, Volts-CN (12 bytes).
- 100 Records are available (0-99).
- COM Port 2 (RS485) is being used (see Log Availability).
- There are no Errors.
- Retrieval is starting at Record Index 0 (oldest record).
- Protocol used is Modbus RTU. The checksum is left off for simplicity.
- The Shark® 200S meter is at device address 1.
- No new records are recorded to the log during the log retrieval process.

1. Read [0xC757, 16 reg], Historical Log 1 Header Block.

Send:	0103 C757 0010
Command:	
Register Address:	0xC757
# Registers:	16

Receive:	010320 00000100 00000064 0012 0000 060717101511 060718101511 0000000000000000
Data:	
Max Records:	0x100 = 256 records maximum.
Num Records:	0x64 = 100 records currently logged.
Record Size:	0x12 = 18 bytes per record.
Log Availability:	0x00 = 0, not in use, available for retrieval.
First Timestamp:	0x060717101511 = July 23, 2006, 16:21:17
Last Timestamp:	0x060717101511 = July 24, 2006, 16:21:17

NOTE: This indicates that Historical Log 1 is available for retrieval.

2. Write 0x0280 -> [0xC34F, 1 reg], Log Enable.

Send:	0106 C34F 0280
Command:	
Register Address:	0xC34F
# Registers:	1 (Write Single Register Command)
Data:	
Log Number:	2 (Historical Log 1)

Enable:	1 (Engage log)
Scope:	0 (Normal Mode)

Receive:	0106C34F0280 (echo)

NOTE: This engages the log for use on this COM Port, and latches the oldest record as record index 0.

3. Read [0xC757, 16 reg], Availability is 0.

Send:	0103 C757 0010
Command:	
Register Address:	0xC757
# Registers:	16

Receive:	010320 00000100 00000064 0012 0002 060717101511 060718101511 0000000000000000
Data:	
Max Records:	0x100 = 256 records maximum.
Num Records:	0x64 = 100 records currently logged.
Record Size:	0x12 = 18 bytes per record.
Log Availability:	0x02 = 2, In use by COM2, RS485 (the current port)
First Timestamp:	0x060717101511 = July 23, 2006, 16:21:17
Last Timestamp:	0x060717101511 = July 24, 2006, 16:21:17

NOTE: This indicates that the log has been engaged properly in step 2. Proceed to retrieve the log.

4. Compute #RecPerWin as (246\18)=13. Write 0x0D01 0000 0000 -> [0xC350, 3 reg] Write Retrieval Info. Set Current Index as 0.

Send:	0110 C350 0003 06 0D01 00 000000
Command:	
Register Address:	0xC350
# Registers:	3, 6 bytes
Data:	
Records per Window:	13. Since the window is 246 bytes, and the record is 18 bytes, 246\18 = 13.66, which means that 13 records evenly fit into a single window. This is 234 bytes, which means later on, we only need to read 234 bytes (117 registers) of the window to retrieve the records.
# of Repeats:	1. We are using auto-increment (so not 0), but not function code 0x23.
Window Status:	0 (ignore)
Record Index:	0, start at the first record.

Receive:	0110C3500003 (command ok)

NOTES:

- This sets up the window for retrieval; now we can start retrieving the records.
- As noted above, we compute the records per window as 246\18 = 13.66, which is rounded to 13 records per window. This allows the minimum number of requests to be made to the meter, which increases retrieval speed.

5. Read [0xC351, 125 reg], first 2 reg is status/index, last 123 reg is window data. Status OK.

Send:	0103 C351 007D
Command:	
Register Address:	0xC351
# Registers:	0x7D, 125 registers

Receive:	0103FA 00000000 060717101511FFFFFFFFFFFFFFFFFFFFFFFF 06071710160042FAAACF42FAAD1842FAA9A8 . . .
Data:	
Window Status:	0x00 = the window is ready.
Index:	0x00 = 0, The window starts with the 0'th record, which is the oldest record.
Record 0:	The next 18 bytes is the 0'th record (filler).
Timestamp:	0x060717101511, = July 23, 2006, 16:21:17
Data:	This record is the "filler" record. It is used by the meter so that there is never 0 records. It should be ignored. It can be identified by the data being all 0xFF. **NOTE:** Once a log has rolled over, the 0'th record will be a valid record, and the filler record will disappear.
Record 1:	The next 18 bytes is the 1'st record.
Timestamp:	0x060717101600 July 23, 2006, 16:22:00
Data:	
Volts AN:	0x42FAAACF, float = 125.33~
Volts BN:	0x42FAAD18, float = 125.33~

Volts CN: 0x42FAA9A8, float = 125.33~

. . . 13 records

NOTES:

- This retrieves the actual window. Repeat this command as many times as necessary to retrieve all of the records when auto-increment is enabled.
- Note the filler record. When a log is reset (cleared) in the meter, the meter always adds a first "filler" record, so that there is always at least 1 record in the log. This "filler" record can be identified by the data being all 0xFF, and it being index 0. If a record has all 0xFF for data, the timestamp is valid, and the index is NOT 0, then the record is legitimate.
- When the "filler" record is logged, its timestamp may not be "on the interval." The next record taken will be on the next "proper interval," adjusted to the hour. For example, if the interval is 1 minute, the first "real" record will be taken on the next minute (no seconds). If the interval is 15 minutes, the next record will be taken at :15, :30, :45, or :00 - whichever of those values is next in sequence.

6. Compare the index with Current Index.

NOTES:

- The Current Index is 0 at this point, and the record index retrieved in step 5 is 0: thus we go to step 8.
- If the Current Index and the record index do not match, go to step 7. The data that was received in the window may be invalid, and should be discarded.

7. Write the Current Index to [0xC351, 2 reg].

Send: 0110 C351 0002 04 00 00000D

Command:

Register Address: 0xC351

Registers: 2, 4 bytes

Data:

Window Status:	0 (ignore)
Record Index:	0x0D = 13, start at the 14th record.

Receive:	0110C3510002 (command ok)

NOTES:

- This step manually sets the record index, and is primarily used when an out-of-order record index is returned on a read (step 6).
- The example assumes that the second window retrieval failed somehow, and we need to recover by requesting the records starting at index 13 again.

8. For each record in the retrieved window, copy and save the data for later interpretation.

9. Increment Current Index by RecordsPerWindow.

NOTES:

- This is the step that determines how much more of the log we need to retrieve.
- On the first N passes, Records Per Window should be 13 (as computed in step 4), and the current index should be a multiple of that (0, 13, 26, . . .). This amount will decrease when we reach the end (see step 10).
- If the current index is greater than or equal to the number of records (in this case 100), then all records have been retrieved; go to step 12. Otherwise, go to step 10 to check if we are nearing the end of the records.

10. If number records - current index < RecordsPerWindow, decrease to match.

NOTES:

- Here we bounds-check the current index, so we don't exceed the records available.
- If the number of remaining records (#records - current index) is less than the Records per Window, then the next window is the last, and contains less than a full window of records. Make records per window equal to remaining records

(#records-current index). In this example, this occurs when current index is 91 (the 8'th window). There are now 9 records available (100-91), so make Records per Window equal 9.

11. Repeat steps 5 through 10.

NOTES:

- Go back to step 5, where a couple of values have changed.

Pass	CurIndex	FirstRecIndex	RecPerWindow
0	0	0	13
1	13	13	13
2	26	26	13
3	39	39	13
4	52	52	13
5	65	65	13
6	78	78	13
7	91	91	9
8	100	------	-------

- At pass 8, since Current Index is equal to the number of records (100), log retrieval should stop; go to step 12 (see step 9 Notes).

12. No more records available, clean up.

13. Write 0x0000 -> [0xC34F, 1 reg], disengage the log.

Send: 0106 C34F 0000

Command:

Register Address: 0xC34F

Registers: 1 (Write Single Register Command)

Data:

Log Number: 0 (ignore)

Enable: 0 (Disengage log)

Scope: 0 (ignore)

Receive: 0106C34F0000 (echo)

NOTES:

- This disengages the log, allowing it to be retrieved by other COM ports.
- The log will automatically disengage if no log retrieval action is taken for 5 minutes.

B.5.5: Log Record Interpretation

The records of each log are composed of a 6 byte timestamp, and N data. The content of the data portion depends on the log.

System Event Record:

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Value	timestamp						Group	Event	Mod	Chan	Param1	Param2	Param3	Param4

Size: 14 bytes (20 bytes image).

Data: The System Event data is 8 bytes; each byte is an enumerated value.

- Group: Group of the event.
- Event: Event within a group.
- Modifier: Additional information about the event, such as number of sectors or log number.
- Channel: The port of the Shark® 200S meter that caused the event.

0	Firmware
1	COM 1 (IrDA)
2	COM 2 (RS485)
7	User (Face Plate)

Param 1-4: These are defined for each event (see following table).

NOTE: The System Log Record is 20 bytes, consisting of the Record Header (12 bytes) and Payload (8 bytes). The Timestamp (6 bytes) is in the header. Typically, software will retrieve only the timestamp and payload, yielding a 14-byte record. The table below shows all defined payloads.

Group (Event group)	Event (Event within group)	Mod (Event modifier)	Channel (1-2 for COMs, 7 for USER, 0 for FW)	Parm1	Parm2	Parm3	Parm4	Comments
0								Startup
	0	0	0	FW version				Meter Run Firmware Startup
1								Log Activity
	1	log#	1-4	0xFF	0xFF	0xFF	0xFF	Reset
	2	log#	1-4	0xFF	0xFF	0xFF	0xFF	Log Retrieval Begin
	3	log#	0-4	0xFF	0xFF	0xFF	0xFF	Log Retrieval End
2								Clock Activity
	1	0	1-4	0xFF	0xFF	0xFF	0xFF	Clock Changed
	2	0	0	0xFF	0xFF	0xFF	0xFF	Daylight Time On
	3	0	0	0xFF	0xFF	0xFF	0xFF	Daylight Time Off
	4	sync method	0	0xFF	0xFF	0xFF	0xFF	Auto Clock Sync Failed
	5	sync method	0	0xFF	0xFF	0xFF	0xFF	Auto Clock Sync Resumed
3								System Resets
	1	0	0-4, 7	0xFF	0xFF	0xFF	0xFF	Max & Min Reset
	2	0	0-4, 7	0xFF	0xFF	0xFF	0xFF	Energy Reset
	3	slot#	0-4	1 (inputs) or 2 (outputs)	0xFF	0xFF	0xFF	Accumulators Reset

4								Settings Activity
	1	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Password Changed
	2	0	1-4	0xFF	0xFF	0xFF	0xFF	V-switch Changed
	3	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Programma-ble Settings Changed
	4	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Measurement Stopped
5								Boot Activity
	1	0	1-4	FW version				Exit to Boot
6								Error Report-ing & Recovery
	4	log #	0	0xFF	0xFF	0xFF	0xFF	Log Babbling Detected
	5	log #	0	# records discarded		time in seconds		Babbling Log Periodic Summary
	6	log #	0	# records discarded		time in seconds		Log Babbling End Detected
	7	sector#	0	error count		stimulus	0xFF	Flash Sector Error
	8	0	0	0xFF	0xFF	0xFF	0xFF	Flash Error Counters Reset
	9	0	0	0xFF	0xFF	0xFF	0xFF	Flash Job Queue Overflow
	10	1	0	0xFF	0Xff	0xFF	0xFF	Bad NTP Configuration
0x88								
	1	sector#	0	log #	0xFF	0xFF	0xFF	acquire sector
	2	sector#	0	log #	0xFF	0xFF	0xFF	release sector
	3	sector#	0	erase count				erase sector
	4	log#	0	0xFF	0xFF	0xFF	0xFF	write log start record

- log# values: 0 = system log, 1 = alarms log, 2-4 = historical logs 1-3, 5 = I/O change log

- sector# values: 0-63
- slot# values: 1-2

NOTES:

- The clock changed event shows the clock value just before the change in the Mod and Parm bytes. Parms are bit-mapped:
  - b31 - b28 month
  - b27 - b23 day
  - b22 daylight savings time flag
  - b20 - b16 hour
  - b13 - b8 minute
  - b5 - b0 second
  - unused bits are always 0
- Sync method: 1 = NTP.
- Stimulus for a flash sector error indicates what the flash was doing when the error occurred: 1 = acquire sector, 2 = startup, 3 = empty sector, 4 = release sector, 5 = write data.
- Flash error counters are reset to zero in the unlikely event that both copies in EEPROM are corrupted.
- The flash job queue is flushed (and log records are lost) in the unlikely event that the queue runs out of space.
- A "babbling log" is one that is saving records faster than the meter can handle long term. When babbling is detected, the log is frozen and no records are appended until babbling ceases. For as long as babbling persists, a summary of records discarded is logged every 60 minutes. Normal logging resumes when there have been no new append attempts for 30 seconds. Onset of babbling occurs when a log fills a flash sector in less than an hour (applies only to Alarm, I/O Change, Histori-

cal, and Power Quality logs) or when a log grows so far beyond its normal bounds that it is in danger of crashing the system. This applies to all logs except the System log, which does not babble. While possible for the other logs during an extended log retrieval session, it is extremely unlikely to occur.

- Logging of diagnostic records may be suppressed via a bit in programmable settings.

Alarm Record:

Byte	0	1	2	3	4	5	6	7	8	9
Value	timestamp						direction	limit#	Value%	

Size: 10 bytes (16 bytes image)

Data: The Alarm record data is 4 bytes, and specifies which limit the event occurred on, and the direction of the event (going out of limit, or coming back into limit).

- Direction: The direction of the alarm event: whether this record indicates the limit going out, or coming back into limit.

1	Going out of limit
2	Coming back into limit

Bit	0	1	2	3	4	5	6	7
Value	type	0	0	0	0	Limit ID		

- Limit Type: Each limit (1-8) has both an above condition and a below condition. Limit Type indicates which of those the record represents.

0	High Limit
1	Low Limit

- Limit ID: The specific limit this record represents. A value in the range 0-7, Limit ID represents Limits 1-8. The specific details for this limit are stored in the programmable settings.

- Value: Depends on the Direction:

- If the record is "Going out of limit," this is the value of the limit when the "Out" condition occurred.

- If the record is "Coming back into limit," this is the "worst" value of the limit during the period of being "out": for High (above) limits, this is the highest value during the "out" period; for Low (below) limits, this is the lowest value during the “out" period.

Byte	0	1	2	3	4	5	6	7	8	9
Value	Identifier		Above Setpoint		Above Hyst.		Below Setpoint		Below Hyst.	

Interpretation of Alarm Data:

To interpret the data from the alarm records, you need the limit data from the Programmable Settings [0x754B, 40 registers].

There are 8 limits, each with an Above Setpoint, and a Below Setpoint. Each setpoint also has a threshold (hysteresis), which is the value at which the limit returns "into" limit after the setpoint has been exceeded. This prevents "babbling" limits, which can be caused by the limit value fluttering over the setpoint, causing it to go in and out of limit continuously.

- Identifier: The first modbus register of the value that is being watched by this limit. While any modbus register is valid, only values that can have a Full Scale will be used by the Shark® 200S meter.

- Above Setpoint: The percent of the Full Scale above which the value for this limit will be considered "out."

  - Valid in the range of -200.0% to +200.0%

  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 105.2% = 1052.)

- Above Hysteresis: The percent of the Full Scale below which the limit will return "into" limit, if it is out. If this value is above the Above Setpoint, this Above limit will be disabled.

  - Valid in the range of -200.0% to +200.0%.

  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 104.1% = 1041.)

- Below Setpoint: The percent of the Full Scale below which the value for this limit will be considered "out."
  - Valid in the range of -200.0% to +200.0%.
  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 93.5% = 935.)

- Below Hysteresis: The percent of the Full Scale above which the limit will return "into" limit, if it is out. If this value is below the Below Setpoint, this Below limit will be disabled.
  - Valid in the range of -200.0% to +200.0%.
  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 94.9% = 949.)

NOTES:

- The Full Scale is the "nominal" value for each of the different types of readings. To compute the Full Scale, use the following formulas:

Current	[CT Numerator] x [CT Multiplier]
Voltage	[PT Numerator] x [PT Multiplier]
Power 3-Phase (WYE)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x 3
Power 3-Phase (Delta)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x 3 x sqrt(3)
Power Single Phase (WYE)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier]
Power Single Phase (Delta)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x sqrt(3)
Frequency (Calibrated at 60 Hz)	60

Frequency (Calibrated at 50 Hz)	50
Power Factor	1.0
Angles	180°

- To interpret a limit alarm fully, you need both the start and end record (for duration).
- There are a few special conditions related to limits:
  - When the meter powers up, it detects limits from scratch. This means that multiple "out of limit" records can be in sequence with no "into limit" records. Cross- reference the System Events for Power Up events.
    - This also means that if a limit is "out," and it goes back in during the power off condition, no "into limit" record will be recorded.
    - The "worst" value of the "into limit" record follows the above restrictions; it only represents the values since power up. Any values before the power up condition are lost.

Historical Log Record:

Byte	0	1	2	3	4	5	6	-	-	N
Value	timestamp						values . . .			

Size: 6+2 x N bytes (12+2 x N bytes), where N is the number of registers stored.

Data: The Historical Log Record data is 2 x N bytes, which contains snapshots of the values of the associated registers at the time the record was taken. Since the meter uses specific registers to log, with no knowledge of the data it contains, the Programmable Settings need to be used to interpret the data in the record. See Historical Logs Programmable Settings for details.

B.5.6: Examples

Log Retrieval Section:

```
send:  01 03 75 40 00 08 - Meter designation
recv:  01 03 10 4D 65 74 72 65 44 65 73 69 6E 67 5F 20 20 20 20 00 00

send:  :01 03 C7 57 00 10 - Historical Log 1 status block
recv:  :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 00 06 08 17 51 08
        00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00

send:  :01 03 79 17 00 40 - Historical Log 1 PS settings
recv:  :01 03 80 13 01 00 01 23 75 23 76 23 77 1F 3F 1F 40 1F 41 1F
        42 1F 43 1F 44 06 0B 06 0C 06 0D 06 0E 17 75 17 76 17 77 18
        67 18 68 18 69 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00

send:  :01 03 79 57 00 40 - ""
recv:  :01 03 80 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 62 62 62 34 34 34 44
        44 62 62 62 62 62 62 00 00 00 00 00 00

send:  :01 03 75 35 00 01 - Energy PS settings
recv:  :01 03 02 83 31 00 00

send:  :01 03 11 93 00 01 - Connected Port ID
recv:  :01 03 02 00 02 00 00

send:  :01 03 C7 57 00 10 - Historical Log 1 status block
recv:  :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 00 06 08 17 51 08
        00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00

send:  :01 03 C3 4F 00 01 - Log Retrieval header
recv:  :01 03 02 FF FF 00 00

send:  :01 10 C3 4F 00 04 08 02 80 05 01 00 00 00 00 - Engage the log
recv:  :01 10 C3 4F 00 04

send:  :01 03 C7 57 00 10 - Historical Log 1 status block
recv:  :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 02 06 08 17 51 08
        00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00
```

```
send:  :01 10 C3 51 00 02 04 00 00 00 00 - Set the retrieval index
recv:  :01 10 C3 51 00 02

send:  :01 03 C3 51 00 40 - Read first half of window
recv:  :01 03 80 00 00 00 00 06 08 17 51 08 00 00 19 00 2F 27 0F 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03
        E8 00 01 00 05 00 00 00 00 00 06 08 17 51 09 00 00 19 00
        2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 03 E8 00 01 00 04 00 00 00 00 00 06 08 17 51 0A
        00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 03 E8 00 00 00 00

send:  :01 03 C3 91 00 30 - Read second half of window
recv:  :01 03 60 00 05 00 00 00 00 00 00 06 08 17 51 0B 00 00 19 00
        2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 03 E8 00 01 00 04 00 00 00 00 00 06 08 17 51 0C
        00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00
        00

send:  :01 03 C3 51 00 40 - Read first half of last window
recv:  :01 03 80 00 00 05 19 06 08 18 4E 35 00 00 19 00 2F 27 0F 00
        00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03
        E8 00 01 00 04 00 00 00 00 00 06 08 18 4E 36 00 00 19 00
        2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 03 E8 00 01 00 04 00 00 00 00 00 06 08 18 4E 37
        00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 03 E8 00 00 00 00

send:  :01 03 C3 91 00 30 - Read second half of last window
recv:  :01 03 60 00 05 00 00 00 00 00 00 06 08 18 4E 38 00 00 19 00
        2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 03 E8 00 01 00 04 00 00 00 00 00 06 08 18 4E 39
        00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00
        00 00 00 00 00 00 00 03 E8 00 00 00 05 00 00 00 00 00 00
        00

send:  :01 06 C3 4F 00 00 - Disengage the log
recv:  :01 06 C3 4F 00 00
```

Sample Historical Log 1 Record:

Historical Log 1 Record and Programmable Settings

```
13|01|00 01|23 75|23 76|23 77|1F 3F 1F 40|1F 41
1F 42|1F 43 1F 44|06 0B 06 0C|06 0D 06 0E|17 75|
17 76|17 77|18 67|18 68|18 69|00 00 . . . . . .
62 62 62 34 34 34 44 44 62 62 62 62 62 62 . . .
```

These are the Item Values:	These are the Type and Size:	These are the Descriptions:
13		- # registers
01		- # sectors
01		- interval
23 75	6 2	- (SINT 2 byte) Volts A THD Maximum
23 76	6 2	- (SINT 2 byte) Volts B THD Maximum
23 77	6 2	- (SINT 2 byte) Volts C THD Maximum
1F 3F 1F 40	3 4	- (Float 4 byte) Volts A Minimum
1F 41 1F 42	3 4	- (Float 4 byte) Volts B Minimum
1F 43 1F 44	3 4	- (Float 4 byte) Volts C Minimum
06 0B 06 0C	4 4	- (Energy 4 byte) VARhr Negative Phase A
06 0D 06 0E	4 4	- (Energy 4 byte) VARhr Negative Phase B
17 75	6 2	- (SINT 2 byte) Volts A 1st Harmonic Magnitude
17 76	6 2	- (SINT 2 byte) Volts A 2nd Harmonic Magnitude
17 77	6 2	- (SINT 2 byte) Volts A 3rd Harmonic Magnitude
18 67	6 2	- (SINT 2 byte) Ib 3rd Harmonic Magnitude
18 68	6 2	- (SINT 2 byte) Ib 4th Harmonic Magnitude
18 69	6 2	- (SINT 2 byte) Ib 5th Harmonic Magnitude

Sample Record

```
06 08 17 51 08 00|00 19|00 2F|27 0F|00 00 00 00|00
00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|03 E8|
00 01|00 05|00 00|00 00|00 00 . . .
```

11 08 17 51 08 00	- August 23, 2011 17:08:00
00 19	- 2.5%
00 2F	- 4.7%
27 0F	- 999.9% (indicates the value isn't valid)
00 00 00 00	- 0
00 00 00 00	- 0
00 00 00 00	- 0
00 00 00 00	- 0
00 00 00 00	- 0

```
03 E8                    - 100.0% (Fundamental)
00 01                    - 0.1%
00 05                    - 0.5%
00 00                    - 0.0%
00 00                    - 0.0%
00 00                    - 0.0%
```

B.6: Important Note Concerning the Shark ® 200S Meter's Modbus Map

In depicting Modbus Registers (Addresses), the Shark® 200S meter's Modbus map uses Holding Registers only.

B.6.1: Hex Representation

The representation shown in the table below is used by developers of Modbus drivers and libraries, SEL 2020/2030 programmers and Firmware Developers. The Shark ® meter's Modbus map also uses this representation.

Hex	Description
0008 - 000F	Meter Serial Number

B.6.2: Decimal Representation

The Shark ® meter's Modbus map defines Holding Registers as (4X) registers. Many popular SCADA and HMI packages and their Modbus drivers have user interfaces that require users to enter these Registers starting at 40001. So instead of entering two separate values, one for register type and one for the actual register, they have been combined into one number.

The Shark ® 200S meter's Modbus map uses a shorthand version to depict the decimal fields, i.e., not all of the digits required for entry into the SCADA package UI are shown. For example:

You need to display the meter's serial number in your SCADA application. The Shark® 200S meter's Modbus map shows the following information for meter serial number:

Decimal	Description
9 - 16	Meter Serial Number

In order to retrieve the meter's serial number, enter 40009 into the SCADA UI as the starting register, and 8 as the number of registers.

- In order to work with SCADA and Driver packages that use the 40001 to 49999 method for requesting holding registers, take 40000 and add the value of the register (Address) in the decimal column of the Modbus Map. Then enter the number (e.g., 4009) into the UI as the starting register.

- For SCADA and Driver packages that use the 400001 to 465536 method for requesting holding registers take 400000 and add the value of the register (Address) in the decimal column of the Modbus Map. Then enter the number (e.g., 400009) into the UI as the starting register. The drivers for these packages strip off the leading four and subtract 1 from the remaining value. This final value is used as the starting register or register to be included when building the actual modbus message.

B.7: Modbus Register Map (MM-1 to MM-15)

The Shark® 200S meter's Modbus Register map begins on the following page.

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Modbus Address

Hex		Decimal		Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
Fixed Data Section									
Identification Block								**read-only**	
0000	- 0007	1	- 8	Meter Name	ASCII	16 char	none		8
0008	- 000F	9	- 16	Meter Serial Number	ASCII	16 char	none		8
0010	- 0010	17	- 17	Meter Type	UINT16	bit-mapped	------st -----vvv	t = 0 s= 1 vvv = V-switch: V33 = standard 200S	1
0011	- 0012	18	- 19	Firmware Version	ASCII	4 char	none		2
0013	- 0013	20	- 20	Map Version	UINT16	0 to 65535	none		1
0014	- 0014	21	- 21	Meter Configuration	UINT16	bit-mapped	-----ccc --ffffff	ccc = CT denominator (1 or 5), ffffff = calibration frequency (50 or 60)	1
0015	- 0015	22	- 22	ASIC Version	UINT16	0-65535	none		1
0016	- 0017	23	- 24	Boot Firmware Version	ASCII	4 char	none		2
0018	- 0018	25	- 25	Reserved					1
0019	- 0019	26	- 26	Reserved					1
001A	- 001D	27	- 30	Meter Type Name	ASCII	8 char	none		4
001E	- 0026	31	- 39	Reserved				Reserved	9
0027	- 002E	40	- 47	Reserved				Reserved	8
								Block Size:	47

Hex		Decimal		Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
Meter Data Section (Note 2)									
Primary Readings Block								**read-only**	
03E7	- 03E8	1000	- 1001	Volts A-N	FLOAT	0 to 9999 M	volts		2
03E9	- 03EA	1002	- 1003	Volts B-N	FLOAT	0 to 9999 M	volts		2
03EB	- 03EC	1004	- 1005	Volts C-N	FLOAT	0 to 9999 M	volts		2
03ED	- 03EE	1006	- 1007	Volts A-B	FLOAT	0 to 9999 M	volts		2
03EF	- 03F0	1008	- 1009	Volts B-C	FLOAT	0 to 9999 M	volts		2
03F1	- 03F2	1010	- 1011	Volts C-A	FLOAT	0 to 9999 M	volts		2
03F3	- 03F4	1012	- 1013	Amps A	FLOAT	0 to 9999 M	amps		2
03F5	- 03F6	1014	- 1015	Amps B	FLOAT	0 to 9999 M	amps		2
03F7	- 03F8	1016	- 1017	Amps C	FLOAT	0 to 9999 M	amps		2
03F9	- 03FA	1018	- 1019	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
03FB	- 03FC	1020	- 1021	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
03FD	- 03FE	1022	- 1023	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
03FF	- 0400	1024	- 1025	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2
0401	- 0402	1026	- 1027	Frequency	FLOAT	0 to 65.00	Hz		2
0403	- 0404	1028	- 1029	Neutral Current	FLOAT	0 to 9999 M	amps		2
0405	- 0406	1030	- 1031	Watts, Phase A	FLOAT	-9999 M to +9999 M	watts	Per phase power and PF have values only for WYE hookup and will be zero for all other hookups.	2
0407	- 0408	1032	- 1033	Watts, Phase B	FLOAT	-9999 M to +9999 M	watts		2
0409	- 040A	1034	- 1035	Watts, Phase C	FLOAT	-9999 M to +9999 M	watts		2
040B	- 040C	1036	- 1037	VARs, Phase A	FLOAT	-9999 M to +9999 M	VARs		2
040D	- 040E	1038	- 1039	VARs, Phase B	FLOAT	-9999 M to +9999 M	VARs		2
040F	- 0410	1040	- 1041	VARs, Phase C	FLOAT	-9999 M to +9999 M	VARs		2
0411	- 0412	1042	- 1043	VAs, Phase A	FLOAT	-9999 M to +9999 M	VAs		2
0413	- 0414	1044	- 1045	VAs, Phase B	FLOAT	-9999 M to +9999 M	VAs		2
0415	- 0416	1046	- 1047	VAs, Phase C	FLOAT	-9999 M to +9999 M	VAs		2
0417	- 0418	1048	- 1049	Power Factor, Phase A	FLOAT	-1.00 to +1.00	none		2
0419	- 041A	1050	- 1051	Power Factor, Phase B	FLOAT	-1.00 to +1.00	none		2
041B	- 041C	1052	- 1053	Power Factor, Phase C	FLOAT	-1.00 to +1.00	none		2
041D	- 0425	1054	- 1062	Reserved				Reserved	9
								Block Size:	63

Primary Energy Block							read-only	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
05DB - 05DC	1500 - 1501	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs	2
05DD - 05DE	1502 - 1503	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received is positive for "view as load", delivered is positive for "view as generator"	2
05DF - 05E0	1504 - 1505	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format	* 5 to 8 digits	2
05E1 - 05E2	1506 - 1507	W-hours, Total	SINT32	0 to 99999999	Wh per energy format		2
05E3 - 05E4	1508 - 1509	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* decimal point implied, per energy format	2
05E5 - 05E6	1510 - 1511	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format		2
05E7 - 05E8	1512 - 1513	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
05E9 - 05EA	1514 - 1515	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2
05EB - 05EC	1516 - 1517	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format	* see note 10	2
05ED - 05EE	1518 - 1519	W-hours, Received, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05EF - 05F0	1520 - 1521	W-hours, Received, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05F1 - 05F2	1522 - 1523	W-hours, Received, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05F3 - 05F4	1524 - 1525	W-hours, Delivered, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05F5 - 05F6	1526 - 1527	W-hours, Delivered, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05F7 - 05F8	1528 - 1529	W-hours, Delivered, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
05F9 - 05FA	1530 - 1531	W-hours, Net, Phase A	SINT32	-99999999 to 99999999	Wh per energy format		2
05FB - 05FC	1532 - 1533	W-hours, Net, Phase B	SINT32	-99999999 to 99999999	Wh per energy format		2
05FD - 05FE	1534 - 1535	W-hours, Net, Phase C	SINT32	-99999999 to 99999999	Wh per energy format		2
05FF - 0600	1536 - 1537	W-hours, Total, Phase A	SINT32	0 to 99999999	Wh per energy format		2
0601 - 0602	1538 - 1539	W-hours, Total, Phase B	SINT32	0 to 99999999	Wh per energy format		2
0603 - 0604	1540 - 1541	W-hours, Total, Phase C	SINT32	0 to 99999999	Wh per energy format		2
0605 - 0606	1542 - 1543	VAR-hours, Positive, Phase A	SINT32	0 to 99999999	VARh per energy format		2
0607 - 0608	1544 - 1545	VAR-hours, Positive, Phase B	SINT32	0 to 99999999	VARh per energy format		2
0609 - 060A	1546 - 1547	VAR-hours, Positive, Phase C	SINT32	0 to 99999999	VARh per energy format		2
060B - 060C	1548 - 1549	VAR-hours, Negative, Phase A	SINT32	0 to -99999999	VARh per energy format		2
060D - 060E	1550 - 1551	VAR-hours, Negative, Phase B	SINT32	0 to -99999999	VARh per energy format		2
060F - 0610	1552 - 1553	VAR-hours, Negative, Phase C	SINT32	0 to -99999999	VARh per energy format		2
0611 - 0612	1554 - 1555	VAR-hours, Net, Phase A	SINT32	-99999999 to 99999999	VARh per energy format		2
0613 - 0614	1556 - 1557	VAR-hours, Net, Phase B	SINT32	-99999999 to 99999999	VARh per energy format		2
0615 - 0616	1558 - 1559	VAR-hours, Net, Phase C	SINT32	-99999999 to 99999999	VARh per energy format		2
0617 - 0618	1560 - 1561	VAR-hours, Total, Phase A	SINT32	0 to 99999999	VARh per energy format		2
0619 - 061A	1562 - 1563	VAR-hours, Total, Phase B	SINT32	0 to 99999999	VARh per energy format		2
061B - 061C	1564 - 1565	VAR-hours, Total, Phase C	SINT32	0 to 99999999	VARh per energy format		2
061D - 061E	1566 - 1567	VA-hours, Phase A	SINT32	0 to 99999999	VAh per energy format		2
061F - 0620	1568 - 1569	VA-hours, Phase B	SINT32	0 to 99999999	VAh per energy format		2
0621 - 0622	1570 - 1571	VA-hours, Phase C	SINT32	0 to 99999999	VAh per energy format		2
						Block Size:	72

Primary Demand Block								read-only	
Hex		Decimal		Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
07CF	- 07D0	2000	- 2001	Amps A, Average	FLOAT	0 to 9999 M	amps		2
07D1	- 07D2	2002	- 2003	Amps B, Average	FLOAT	0 to 9999 M	amps		2
07D3	- 07D4	2004	- 2005	Amps C, Average	FLOAT	0 to 9999 M	amps		2
07D5	- 07D6	2006	- 2007	Positive Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07D7	- 07D8	2008	- 2009	Positive VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07D9	- 07DA	2010	- 2011	Negative Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07DB	- 07DC	2012	- 2013	Negative VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07DD	- 07DE	2014	- 2015	VAs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VAs		2
07DF	- 07E0	2016	- 2017	Positive PF, 3-Ph, Average	FLOAT	-1.00 to +1.00	none		2
07E1	- 07E2	2018	- 2019	Negative PF, 3-PF, Average	FLOAT	-1.00 to +1.00	none		2
07E3	- 07E4	2020	- 2021	Neutral Current, Average	FLOAT	0 to 9999 M	amps		2
07E5	- 07E6	2022	- 2023	Positive Watts, Phase A, Average	FLOAT	-9999 M to +9999 M	watts		2
07E7	- 07E8	2024	- 2025	Positive Watts, Phase B, Average	FLOAT	-9999 M to +9999 M	watts		2
07E9	- 07EA	2026	- 2027	Positive Watts, Phase C, Average	FLOAT	-9999 M to +9999 M	watts		2
07EB	- 07EC	2028	- 2029	Positive VARs, Phase A, Average	FLOAT	-9999 M to +9999 M	VARs		2
07ED	- 07EE	2030	- 2031	Positive VARs, Phase B, Average	FLOAT	-9999 M to +9999 M	VARs		2
07EF	- 07F0	2032	- 2033	Positive VARs, Phase C, Average	FLOAT	-9999 M to +9999 M	VARs		2
07F1	- 07F2	2034	- 2035	Negative Watts, Phase A, Average	FLOAT	-9999 M to +9999 M	watts		2
07F3	- 07F4	2036	- 2037	Negative Watts, Phase B, Average	FLOAT	-9999 M to +9999 M	watts		2
07F5	- 07F6	2038	- 2039	Negative Watts, Phase C, Average	FLOAT	-9999 M to +9999 M	watts		2
07F7	- 07F8	2040	- 2041	Negative VARs, Phase A, Average	FLOAT	-9999 M to +9999 M	VARs		2
07F9	- 07FA	2042	- 2043	Negative VARs, Phase B, Average	FLOAT	-9999 M to +9999 M	VARs		2
07FB	- 07FC	2044	- 2045	Negative VARs, Phase C, Average	FLOAT	-9999 M to +9999 M	VARs		2
07FD	- 07FE	2046	- 2047	VAs, Phase A, Average	FLOAT	-9999 M to +9999 M	VAs		2
07FF	- 0800	2048	- 2049	VAs, Phase B, Average	FLOAT	-9999 M to +9999 M	VAs		2
0801	- 0802	2050	- 2051	VAs, Phase C, Average	FLOAT	-9999 M to +9999 M	VAs		2
0803	- 0804	2052	- 2053	Positive PF, Phase A, Average	FLOAT	-1.00 to +1.00	none		2
0805	- 0806	2054	- 2055	Positive PF, Phase B, Average	FLOAT	-1.00 to +1.00	none		2
0807	- 0808	2056	- 2057	Positive PF, Phase C, Average	FLOAT	-1.00 to +1.00	none		2
0809	- 080A	2058	- 2059	Negative PF, Phase A, Average	FLOAT	-1.00 to +1.00	none		2
080B	- 080C	2060	- 2061	Negative PF, Phase B, Average	FLOAT	-1.00 to +1.00	none		2
080D	- 080E	2062	- 2063	Negative PF, Phase C, Average	FLOAT	-1.00 to +1.00	none		2
								Block Size:	64

Uncompensated Readings Block						read-only	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
0BB7 - 0BB8	3000 - 3001	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
0BB9 - 0BBA	3002 - 3003	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
0BBB - 0BBC	3004 - 3005	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
0BBD - 0BBE	3006 - 3007	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2
0BBF - 0BC0	3008 - 3009	Watts, Phase A	FLOAT	-9999 M to +9999 M	watts	Per phase power and PF have values only for WYE hookup and will be zero for all other hookups.	2
0BC1 - 0BC2	3010 - 3011	Watts, Phase B	FLOAT	-9999 M to +9999 M	watts		2
0BC3 - 0BC4	3012 - 3013	Watts, Phase C	FLOAT	-9999 M to +9999 M	watts		2
0BC5 - 0BC6	3014 - 3015	VARs, Phase A	FLOAT	-9999 M to +9999 M	VARs		2
OBC7 - 0BC8	3016 - 3017	VARs, Phase B	FLOAT	-9999 M to +9999 M	VARs		2
0BC9 - 0BCA	3018 - 3019	VARs, Phase C	FLOAT	-9999 M to +9999 M	VARs		2
0BCB - 0BCC	3020 - 3021	VAs, Phase A	FLOAT	-9999 M to +9999 M	VAs		2
0BCD - 0BCE	3022 - 3023	VAs, Phase B	FLOAT	-9999 M to +9999 M	VAs		2
0BCF - 0BD0	3024 - 3025	VAs, Phase C	FLOAT	-9999 M to +9999 M	VAs		2
0BD1 - 0BD2	3026 - 3027	Power Factor, Phase A	FLOAT	-1.00 to +1.00	none		2
0BD3 - 0BD4	3028 - 3029	Power Factor, Phase B	FLOAT	-1.00 to +1.00	none		2
0BD5 - 0BD6	3030 - 3031	Power Factor, Phase C	FLOAT	-1.00 to +1.00	none		2
0BD7 - 0BD8	3032 - 3033	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs	2
0BD9 - 0BDA	3034 - 3035	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received is positive for "view as load", delivered is positive for "view as generator"	2
0BDB - 0BDC	3036 - 3037	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format	* 5 to 8 digits	2
0BDD - 0BDE	3038 - 3039	W-hours, Total	SINT32	0 to 99999999	Wh per energy format		2
0BDF - 0BE0	3040 - 3041	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* decimal point implied, per energy format	2
0BE1 - 0BE2	3042 - 3043	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format		2
0BE3 - 0BE4	3044 - 3045	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
0BE5 - 0BE6	3046 - 3047	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2
0BE7 - 0BE8	3048 - 3049	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format	* see note 10	2
0BE9 - 0BEA	3050 - 3051	W-hours, Received, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BEB - 0BEC	3052 - 3053	W-hours, Received, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BED - 0BEE	3054 - 3055	W-hours, Received, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BEF - 0BF0	3056 - 3057	W-hours, Delivered, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BF1 - 0BF2	3058 - 3059	W-hours, Delivered, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BF3 - 0BF4	3060 - 3061	W-hours, Delivered, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2
0BF5 - 0BF6	3062 - 3063	W-hours, Net, Phase A	SINT32	-99999999 to 99999999	Wh per energy format		2
0BF7 - 0BF8	3064 - 3065	W-hours, Net, Phase B	SINT32	-99999999 to 99999999	Wh per energy format		2
0BF9 - 0BFA	3066 - 3067	W-hours, Net, Phase C	SINT32	-99999999 to 99999999	Wh per energy format		2
0BFB - 0BFC	3068 - 3069	W-hours, Total, Phase A	SINT32	0 to 99999999	Wh per energy format		2
0BFD - 0BFE	3070 - 3071	W-hours, Total, Phase B	SINT32	0 to 99999999	Wh per energy format		2
0BFF - 0C00	3072 - 3073	W-hours, Total, Phase C	SINT32	0 to 99999999	Wh per energy format		2
0C01 - 0C02	3074 - 3075	VAR-hours, Positive, Phase A	SINT32	0 to 99999999	VARh per energy format		2
0C03 - 0C04	3076 - 3077	VAR-hours, Positive, Phase B	SINT32	0 to 99999999	VARh per energy format		2
0C05 - 0C06	3078 - 3079	VAR-hours, Positive, Phase C	SINT32	0 to 99999999	VARh per energy format		2
0C07 - 0C08	3080 - 3081	VAR-hours, Negative, Phase A	SINT32	0 to -99999999	VARh per energy format		2
0C09 - 0C0A	3082 - 3083	VAR-hours, Negative, Phase B	SINT32	0 to -99999999	VARh per energy format		2
0C0B - 0C0C	3084 - 3085	VAR-hours, Negative, Phase C	SINT32	0 to -99999999	VARh per energy format		2
0C0D - 0C0E	3086 - 3087	VAR-hours, Net, Phase A	SINT32	-99999999 to 99999999	VARh per energy format		2
0C0F - 0C10	3088 - 3089	VAR-hours, Net, Phase B	SINT32	-99999999 to 99999999	VARh per energy format		2
0C11 - 0C12	3090 - 3091	VAR-hours, Net, Phase C	SINT32	-99999999 to 99999999	VARh per energy format		2
0C13 - 0C14	3092 - 3093	VAR-hours, Total, Phase A	SINT32	0 to 99999999	VARh per energy format		2
0C15 - 0C16	3094 - 3095	VAR-hours, Total, Phase B	SINT32	0 to 99999999	VARh per energy format		2
0C17 - 0C18	3096 - 3097	VAR-hours, Total, Phase C	SINT32	0 to 99999999	VARh per energy format		2
0C19 - 0C1A	3098 - 3099	VA-hours, Phase A	SINT32	0 to 99999999	VAh per energy format		2
0C1B - 0C1C	3100 - 3101	VA-hours, Phase B	SINT32	0 to 99999999	VAh per energy format		2
0C1D - 0C1E	3102 - 3103	VA-hours, Phase C	SINT32	0 to 99999999	VAh per energy format		2
						Block Size:	104

Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
Phase Angle Block						**read-only**	
1003 - 1003	4100 - 4100	Phase A Current	SINT16	-1800 to +1800	0.1 degree		1
1004 - 1004	4101 - 4101	Phase B Current	SINT16	-1800 to +1800	0.1 degree		1
1005 - 1005	4102 - 4102	Phase C Current	SINT16	-1800 to +1800	0.1 degree		1
1006 - 1006	4103 - 4103	Angle, Volts A-B	SINT16	-1800 to +1800	0.1 degree		1
1007 - 1007	4104 - 4104	Angle, Volts B-C	SINT16	-1800 to +1800	0.1 degree		1
1008 - 1008	4105 - 4105	Angle, Volts C-A	SINT16	-1800 to +1800	0.1 degree		1
						Block Size:	6
Status Block						**read-only**	
1193 - 1193	4500 - 4500	Port ID	UINT16	1 to 4	none	Identifies which Shark COM port a master is connected to; 1 for COM1, 2 for COM2, etc.	1
1194 - 1194	4501 - 4501	Meter Status	UINT16	bit-mapped	mmmpch-- -ffeeccc	mmm = measurement state (0=off, 1=running normally, 2=limp mode, 3=warmup, 6&7=boot, others unused) See note 16. pch = NVMEM block OK flags (p=profile, c=calibration, h=header), flag is 1 if OK ff = flash state (0=initializing, 1=logging disabled by Vswitch, 3=logging) ee = edit state (0=startup, 1=normal, 2=privileged command session, 3=profile update mode) ccc = port enabled for edit(0=none, 1-4=COM1-COM4, 7=front panel)	1
1195 - 1195	4502 - 4502	Limits Status	UINT16	bit-mapped	87654321 87654321	high byte is setpt 1, 0=in, 1=out low byte is setpt 2, 0=in, 1=out see notes 11, 12, 17	1
1196 - 1197	4503 - 4504	Time Since Reset	UINT32	0 to 4294967294	4 msec	wraps around after max count	2
1198 - 119A	4505 - 4507	Meter On Time	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
119B - 119D	4508 - 4510	Current Date and Time	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
119E - 119E	4511 - 4511	Reserved				Reserved	1
119F - 119F	4512 - 4512	Current Day of Week	UINT16	1 to 7	1 day	1=Sun, 2=Mon, etc.	1
						Block Size:	13
						Block Size:	876
Short term Primary Minimum Block						**read-only**	
1F27 - 1F28	7976 - 7977	Volts A-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts	Minimum instantaneous value measured during the demand interval before the one most recently completed.	2
1F29 - 1F2A	7978 - 7979	Volts B-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F2B - 1F2C	7980 - 7981	Volts C-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F2D - 1F2E	7982 - 7983	Volts A-B, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F2F - 1F30	7984 - 7985	Volts B-C, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F31 - 1F32	7986 - 7987	Volts C-A, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F33 - 1F34	7988 - 7989	Volts A-N, Short Term Minimum	FLOAT	0 to 9999 M	volts	Minimum instantaneous value measured during the most recently completed demand interval.	2
1F35 - 1F36	7990 - 7991	Volts B-N, Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F37 - 1F38	7992 - 7993	Volts C-N, Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F39 - 1F3A	7994 - 7995	Volts A-B, Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F3B - 1F3C	7996 - 7997	Volts B-C, Short Term Minimum	FLOAT	0 to 9999 M	volts		2
1F3D - 1F3E	7998 - 7999	Volts C-A, Short Term Minimum	FLOAT	0 to 9999 M	volts		2
						Block Size:	24

Primary Minimum Block						read-only	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
1F3F - 1F40	8000 - 8001	Volts A-N, Minimum	FLOAT	0 to 9999 M	volts		2
1F41 - 1F42	8002 - 8003	Volts B-N, Minimum	FLOAT	0 to 9999 M	volts		2
1F43 - 1F44	8004 - 8005	Volts C-N, Minimum	FLOAT	0 to 9999 M	volts		2
1F45 - 1F46	8006 - 8007	Volts A-B, Minimum	FLOAT	0 to 9999 M	volts		2
1F47 - 1F48	8008 - 8009	Volts B-C, Minimum	FLOAT	0 to 9999 M	volts		2
1F49 - 1F4A	8010 - 8011	Volts C-A, Minimum	FLOAT	0 to 9999 M	volts		2
1F4B - 1F4C	8012 - 8013	Amps A, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
1F4D - 1F4E	8014 - 8015	Amps B, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
1F4F - 1F50	8016 - 8017	Amps C, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
1F51 - 1F52	8018 - 8019	Positive Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
1F53 - 1F54	8020 - 8021	Positive VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
1F55 - 1F56	8022 - 8023	Negative Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
1F57 - 1F58	8024 - 8025	Negative VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
1F59 - 1F5A	8026 - 8027	VAs, 3-Ph, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
1F5B - 1F5C	8028 - 8029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F5D - 1F5E	8030 - 8031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F5F - 1F60	8032 - 8033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2
1F61 - 1F62	8034 - 8035	Neutral Current, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
1F63 - 1F64	8036 - 8037	Positive Watts, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F65 - 1F66	8038 - 8039	Positive Watts, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F67 - 1F68	8040 - 8041	Positive Watts, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F69 - 1F6A	8042 - 8043	Positive VARs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F6B - 1F6C	8044 - 8045	Positive VARs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F6D - 1F6E	8046 - 8047	Positive VARs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F6F - 1F70	8048 - 8049	Negative Watts, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F71 - 1F72	8050 - 8051	Negative Watts, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F73 - 1F74	8052 - 8053	Negative Watts, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
1F75 - 1F76	8054 - 8055	Negative VARs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F77 - 1F78	8056 - 8057	Negative VARs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F79 - 1F7A	8058 - 8059	Negative VARs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
1F7B - 1F7C	8060 - 8061	VAs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
1F7D - 1F7E	8062 - 8063	VAs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
1F7F - 1F80	8064 - 8065	VAs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
1F81 - 1F82	8066 - 8067	Positive PF, Phase A, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F83 - 1F84	8068 - 8069	Positive PF, Phase B, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F85 - 1F86	8070 - 8071	Positive PF, Phase C, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F87 - 1F88	8072 - 8073	Negative PF, Phase A, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F89 - 1F8A	8074 - 8075	Negative PF, Phase B, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F8B - 1F8C	8076 - 8077	Negative PF, Phase C, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
1F8D - 1F8D	8078 - 8078	Reserved					1
1F8E - 1F8E	8079 - 8079	Reserved					1
1F8F - 1F8F	8080 - 8080	Reserved					1
1F90 - 1F90	8081 - 8081	Reserved					1
1F91 - 1F91	8082 - 8082	Reserved					1
1F92 - 1F92	8083 - 8083	Reserved					1
1F93 - 1F9B	8084 - 8092	Reserved				Reserved	9
						Block Size:	93

Primary Minimum Timestamp Block						read-only	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
20CF - 20D1	8400 - 8402	Volts A-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20D2 - 20D4	8403 - 8405	Volts B-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20D5 - 20D7	8406 - 8408	Volts C-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20D8 - 20DA	8409 - 8411	Volts A-B, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20DB - 20DD	8412 - 8414	Volts B-C, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20DE - 20E0	8415 - 8417	Volts C-A, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20E1 - 20E3	8418 - 8420	Amps A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20E4 - 20E6	8421 - 8423	Amps B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20E7 - 20E9	8424 - 8426	Amps C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20EA - 20EC	8427 - 8429	Positive Watts, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20ED - 20EF	8430 - 8432	Positive VARs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20F0 - 20F2	8433 - 8435	Negative Watts, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20F3 - 20F5	8436 - 8438	Negative VARs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20F6 - 20F8	8439 - 8441	VAs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20F9 - 20FB	8442 - 8444	Positive Power Factor, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20FC - 20FE	8445 - 8447	Negative Power Factor, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
20FF - 2101	8448 - 8450	Frequency, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2102 - 2104	8451 - 8453	Neutral Current, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2100	1 sec		3
2105 - 2107	8454 - 8456	Positive Watts, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2108 - 210A	8457 - 8459	Positive Watts, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
210B - 210D	8460 - 8462	Positive Watts, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
210E - 2110	8463 - 8465	Positive VARs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2111 - 2113	8466 - 8468	Positive VARs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2114 - 2116	8469 - 8471	Positive VARs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2117 - 2119	8472 - 8474	Negative Watts, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
211A - 211C	8475 - 8477	Negative Watts, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
211D - 211F	8478 - 8480	Negative Watts, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2120 - 2122	8481 - 8483	Negative VARs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2123 - 2125	8484 - 8486	Negative VARs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2126 - 2128	8487 - 8489	Negative VARs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2129 - 212B	8490 - 8492	VAs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
212C - 212E	8493 - 8495	VAs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
212F - 2131	8496 - 8498	VAs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2132 - 2134	8499 - 8501	Positive PF, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2135 - 2137	8502 - 8504	Positive PF, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2138 - 213A	8505 - 8507	Positive PF, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
213B - 213D	8508 - 8510	Negative PF, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
213E - 2140	8511 - 8513	Negative PF, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2141 - 2143	8514 - 8516	Negative PF, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2144 - 2146	8517 - 8519	Reserved					3
2147 - 2149	8520 - 8522	Reserved					3
214A - 214C	8523 - 8525	Reserved					3
214D - 214F	8526 - 8528	Reserved					3
2150 - 2152	8529 - 8531	Reserved					3
2153 - 2155	8532 - 8534	Reserved					3
2156 - 2167	8535 - 8552	Reserved				Reserved	18
						Block Size:	153

Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
Short term Primary Maximum Block						**read-only**	
230F - 2310	8976 - 8977	Volts A-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts	Maximum instantaneous value measured during the demand interval before the one most recently completed.	
2311 - 2312	8978 - 8979	Volts B-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts		
2313 - 2314	8980 - 8981	Volts C-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts		
2315 - 2316	8982 - 8983	Volts A-B, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts		
2317 - 2318	8984 - 8985	Volts B-C, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts		
2319 - 231A	8986 - 8987	Volts C-A, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts		
231B - 231C	8988 - 8989	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts	Maximum instantaneous value measured during the most recently completed demand interval.	2
231D - 231E	8990 - 8991	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
232F - 2320	8992 - 8993	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
2321 - 2322	8994 - 8995	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
2323 - 2324	8996 - 8997	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
2325 - 2326	8998 - 8999	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
						Block Size:	12
Primary Maximum Block						**read-only**	
2327 - 2328	9000 - 9001	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2
2329 - 232A	9002 - 9003	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
232B - 232C	9004 - 9005	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
232D - 232E	9006 - 9007	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
232F - 2330	9008 - 9009	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
2331 - 2332	9010 - 9011	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
2333 - 2334	9012 - 9013	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
2335 - 2336	9014 - 9015	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
2337 - 2338	9016 - 9017	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
2339 - 233A	9018 - 9019	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
233B - 233C	9020 - 9021	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
233D - 233E	9022 - 9023	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
233F - 2340	9024 - 9025	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
2341 - 2342	9026 - 9027	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
2343 - 2344	9028 - 9029	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
2345 - 2346	9030 - 9031	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
2347 - 2348	9032 - 9033	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2
2349 - 234A	9034 - 9035	Neutral Current, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
234B - 234C	9036 - 9037	Positive Watts, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
234D - 234E	9038 - 9039	Positive Watts, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
234F - 2350	9040 - 9041	Positive Watts, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
2351 - 2352	9042 - 9043	Positive VARs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
2353 - 2354	9044 - 9045	Positive VARs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
2355 - 2356	9046 - 9047	Positive VARs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
2357 - 2358	9048 - 9049	Negative Watts, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
2359 - 235A	9050 - 9051	Negative Watts, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
235B - 235C	9052 - 9053	Negative Watts, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2
235D - 235E	9054 - 9055	Negative VARs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
235F - 2360	9056 - 9057	Negative VARs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
2361 - 2362	9058 - 9059	Negative VARs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2
2363 - 2364	9060 - 9061	VAs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
2365 - 2366	9062 - 9063	VAs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
2367 - 2368	9064 - 9065	VAs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
2369 - 236A	9066 - 9067	Positive PF, Phase A, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
236B - 236C	9068 - 9069	Positive PF, Phase B, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
236D - 236E	9070 - 9071	Positive PF, Phase C, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
236F - 2370	9072 - 9073	Negative PF, Phase A, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
2371 - 2372	9074 - 9075	Negative PF, Phase B, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
2373 - 2374	9076 - 9077	Negative PF, Phase C, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
2375 - 2375	9078 - 9078	Reserved					1
2376 - 2376	9079 - 9079	Reserved					1
2377 - 2377	9080 - 9080	Reserved					1
2378 - 2378	9081 - 9081	Reserved					1
2379 - 2379	9082 - 9082	Reserved					1
237A - 237A	9083 - 9083	Reserved					1
237B - 2383	9084 - 9092	Reserved				Reserved	9
						Block Size:	93

Primary Maximum Timestamp Block							read-only	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
24B7 - 24B9	9400 - 9402	Volts A-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24BA - 24BC	9403 - 9405	Volts B-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24BD - 24BF	9406 - 9408	Volts C-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24C0 - 24C2	9409 - 9411	Volts A-B, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24C3 - 24C5	9412 - 9414	Volts B-C, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24C6 - 24C8	9415 - 9417	Volts C-A, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24C9 - 24CB	9418 - 9420	Amps A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24CC - 24CE	9421 - 9423	Amps B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24CF - 24D1	9424 - 9426	Amps C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24D2 - 24D4	9427 - 9429	Positive Watts, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24D5 - 24D7	9430 - 9432	Positive VARs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24D8 - 24DA	9433 - 9435	Negative Watts, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24DB - 24DD	9436 - 9438	Negative VARs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24DE - 24E0	9439 - 9441	VAs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24E1 - 24E3	9442 - 9444	Positive Power Factor, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24E4 - 24E6	9445 - 9447	Negative Power Factor, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24E7 - 24E9	9448 - 9450	Frequency, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24EA - 24EC	9451 - 9453	Neutral Current, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2100	1 sec		3
24ED - 24EF	9454 - 9456	Positive Watts, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24F0 - 24F2	9457 - 9459	Positive Watts, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24F3 - 24F5	9460 - 9462	Positive Watts, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24F6 - 24F8	9463 - 9465	Positive VARs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24F9 - 24FB	9466 - 9468	Positive VARs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24FC - 24FE	9469 - 9471	Positive VARs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
24FF - 2501	9472 - 9474	Negative Watts, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2502 - 2504	9475 - 9477	Negative Watts, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2505 - 2507	9478 - 9480	Negative Watts, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2508 - 250A	9481 - 9483	Negative VARs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
250B - 250D	9484 - 9486	Negative VARs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
250E - 2510	9487 - 9489	Negative VARs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2511 - 2513	9490 - 9492	VAs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2514 - 2516	9493 - 9495	VAs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2517 - 2519	9496 - 9498	VAs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
251A - 251C	9499 - 9501	Positive PF, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
251D - 251F	9502 - 9504	Positive PF, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2520 - 2522	9505 - 9507	Positive PF, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2523 - 2525	9508 - 9510	Negative PF, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2526 - 2528	9511 - 9513	Negative PF, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
2529 - 252B	9514 - 9516	Negative PF, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
252C - 252E	9517 - 9519	Reserved					3
252F - 2531	9520 - 9522	Reserved					3
2532 - 2534	9523 - 9525	Reserved					3
2535 - 2537	9526 - 9528	Reserved					3
2538 - 253A	9529 - 9531	Reserved					3
253B - 253D	9532 - 9534	Reserved					3
253E - 254F	9535 - 9552	Reserved				Reserved	18
						Block Size:	153

Commands Section (Note 4)							
Resets Block (Note 9)						**write-only**	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
4E1F - 4E1F	20000 - 20000	Reset Max/Min Blocks	UINT16	password (Note 5)			1
4E20 - 4E20	20001 - 20001	Reset Energy Accumulators	UINT16	password (Note 5)			1
4E21 - 4E21	20002 - 20002	Reset Alarm Log (Note 21)	UINT16	password (Note 5)		Reply to a reset log command indicates that the command was accepted but not necessarily that the reset is finished. Poll log status block to determine this.	1
4E22 - 4E22	20003 - 20003	Reset System Log (Note 21)	UINT16	password (Note 5)			1
4E23 - 4E23	20004 - 20004	Reset Historical Log 1 (Note 21)	UINT16	password (Note 5)			1
4E24 - 4E24	20005 - 20005	Reset Historical Log 2 (Note 21)	UINT16	password (Note 5)			1
4E25 - 4E25	20006 - 20006	Reset Historical Log 3 (Note 21)	UINT16	password (Note 5)			1
4E26 - 4E26	20007 - 20007	Reserved					1
4E27 - 4E2E	20008 - 20015	Reserved				Set to 0.	2
4E29 - 4E2A	20010 - 20011	Reserved				Reserved	2
4E2B - 4E2B	20012 - 20012	Reserved					1
4E2C - 4E2C	20013 - 20013	Reserved					1
4E2D - 4E2D	20014 - 20014	Reserved					1
4E2E - 4E2E	20015 - 20015	Reserved					1
						Block Size:	16
Privileged Commands Block						**conditional write**	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
5207 - 5207	21000 - 21000	Initiate Meter Firmware Reprogramming	UINT16	password (Note 5)			1
5208 - 5208	21001 - 21001	Force Meter Restart	UINT16	password (Note 5)		causes a watchdog reset, always reads 0	1
5209 - 5209	21002 - 21002	Open Privileged Command Session	UINT16	password (Note 5)		meter will process command registers (this register through 'Close Privileged Command Session' register below) for 5 minutes or until the session is closed, whichever comes first.	1
520A - 520A	21003 - 21003	Initiate Programmable Settings Update	UINT16	password (Note 5)		meter enters PS update mode	1
520B - 520B	21004 - 21004	Calculate Programmable Settings Checksum (Note 3)	UINT16	0000 to 9999		meter calculates checksum on RAM copy of PS block	1
520C - 520C	21005 - 21005	Programmable Settings Checksum (Note 3)	UINT16	0000 to 9999		read/write checksum register; PS block saved in nonvolatile memory on write (Note 8)	1
520D - 520D	21006 - 21006	Write New Password (Note 3)	UINT16	0000 to 9999		write-only register; always reads zero	1
520E - 520E	21007 - 21007	Terminate Programmable Settings Update (Note 3)	UINT16	any value		meter leaves PS update mode via reset	1
520F - 5211	21008 - 21010	Set Meter Clock	TSTAMP	1Jan2000 - 31Dec2099	1 sec	saved only when 3rd register is written	3
5212 - 5212	21011 - 21011	Reserved				Reserved	1
5213 - 5219	21012 - 21018	Reserved				Reserved	7
521A - 521A	21019 - 21019	Close Privileged Command Session	UINT16	any value		ends an open command session	1
						Block Size:	20
Encryption Block						**read/write**	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
658F - 659A	26000 - 26011	Perform a Secure Operation	UINT16			encrypted command to read password or change meter type	12
						Block Size:	12

Programmable Settings Section								
Basic Setups Block							write only in PS update mode	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution		Comments	# Reg
752F - 752F	30000 - 30000	CT multiplier & denominator	UINT16	bit-mapped	dddddddd mmmmmmmm		high byte is denominator (1 or 5, read-only), low byte is multiplier (1, 10, or 100)	1
7530 - 7530	30001 - 30001	CT numerator	UINT16	1 to 9999	none			1
7531 - 7531	30002 - 30002	PT numerator	UINT16	1 to 9999	none			1
7532 - 7532	30003 - 30003	PT denominator	UINT16	1 to 9999	none			1
7533 - 7533	30004 - 30004	PT multiplier & hookup	UINT16	bit-mapped	mmmmmmmm mmmmhhhh		mm…mm = PT multiplier (1, 10, 100, or 1000) hhhh = hookup enumeration (0 = 3 element wye[9S], 1 = delta 2 CTs[5S], 3 = 2.5 element wye[6S])	1
7534 - 7534	30005 - 30005	Averaging Method	UINT16	bit-mapped	--iiiiii b----sss		iiiiii = interval (5,15,30,60) b = 0-block or 1-rolling sss = # subintervals (1,2,3,4)	1
7535 - 7535	30006 - 30006	Power & Energy Format	UINT16	bit-mapped	ppppiinn feee-ddd		pppp = power scale (0-unit, 3-kilo, 6-mega, 8-auto) ii = power digits after decimal point (0-3), applies only if f=1 and pppp is not auto nn = number of energy digits (5-8 --> 0-3) eee = energy scale (0-unit, 3-kilo, 6-mega) f = decimal point for power (0=data-dependant placement, 1=fixed placement per ii value) ddd = energy digits after decimal point (0-6) See note 10.	1
7536 - 7536	30007 - 30007	Operating Mode Screen Enables	UINT16	bit-mapped	-------x eeeeeeee		eeeeeeee = op mode screen rows on/off, rows top to bottom are bits low order to high order x = set to suppress PF on W/VAR/PF screens	1
7537 - 7537	30008 - 30008	Daylight Saving On Rule	UINT16	bit-mapped	hhhhhwww -dddmmmm		applies only if daylight savings in User Settings Flags = on; specifies when to make changeover hhhhh = hour, 0-23 www = week, 1-4 for 1st - 4th, 5 for last ddd = day of week, 1-7 for Sun - Sat mmmm = month, 1-12 Example: 2AM on the 4th Sunday of March hhhhh=2, www=4, ddd=1, mmmm=3	1
7538 - 7538	30009 - 30009	Daylight Saving Off Rule	UINT16	bit-mapped	hhhhhwww -dddmmmm			1
7539 - 753D	30010 - 30014	Reserved					Reserved	5
753E - 753E	30015 - 30015	User Settings Flags	UINT16	bit-mapped	---g-inn srpdywfa		g = enable alternate full scale bar graph current (1=on, 0=off) i = fixed scale and format current display 0=normal autoscaled current display 1=always show amps with no decimal places nn = number of phases for voltage & current screen (3=ABC, 2=AB, 1=A, 0=ABC) s = scroll (1=on, 0=off) r = password for reset in use (1=on, 0=off) p = password for configuration in use (1=on, 0=off) d = daylight saving time changes (0=off, 1=on) y = diagnostic events in system log (1=yes, 0=no) w = power direction (0=view as load, 1=view as generator) f = flip power factor sign (1=yes, 0=no) a = apparent power computation method (0=arithmetic sum, 1=vector sum)	1
753F - 753F	30016 - 30016	Full Scale Current (for load % bar graph)	UINT16	0 to 9999	none		If non-zero and user settings bit g is set, this value replaces CT numerator in the full scale current calculation. (See Note 12)	1

Basic Setups Block - continued						write only in PS update mode	1
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
7540 - 7547	30017 - 30024	Meter Designation	ASCII	16 char	none		8
7548 - 7548	30025 - 30025	COM1 setup	UINT16	bit-mapped	----dddd -0100110	dddd = reply delay (* 50 msec) ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600)	1
7549 - 7549	30026 - 30026	COM2 setup	UINT16	bit-mapped	----dddd -ppp-bbb		1
754A - 754A	30027 - 30027	COM2 address	UINT16	1 to 247	none		1
754B - 754B	30028 - 30028	Limit #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see notes 7, 11, 12)	1
754C - 754C	30029 - 30029	Limit #1 Out High Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "above" limit (LM1), see notes 11-12.	1
754D - 754D	30030 - 30030	Limit #1 In High Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "above" limit clears; normally less than or equal to the "above" setpoint; see notes 11-12.	1
754E - 754E	30031 - 30031	Limit #1 Out Low Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "below" limit (LM2), see notes 11-12.	1
754F - 754F	30032 - 30032	Limit #1 In Low Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "below" limit clears; normally greater than or equal to the "below" setpoint; see notes 11-12.	1
7550 - 7554	30033 - 30037	Limit #2	SINT16	same as Limit #1	same as Limit #1	same as Limit #1	5
7555 - 7559	30038 - 30042	Limit #3	SINT16				5
755A - 755E	30043 - 30047	Limit #4	SINT16				5
755F - 7563	30048 - 30052	Limit #5	SINT16				5
7564 - 7568	30053 - 30057	Limit #6	SINT16				5
7569 - 756D	30058 - 30062	Limit #7	SINT16				5
756E - 7572	30063 - 30067	Limit #8	SINT16				5
7573 - 7582	30068 - 30083	Reserved				Reserved	16
7583 - 75C2	30084 - 30147	Reserved				Reserved	64
75C3 - 75C3	30148 - 30148	watts loss due to iron when watts positive	UINT16	0 to 99.99	0.0001		1
75C4 - 75C4	30149 - 30149	watts loss due to copper when watts positive	UINT16	0 to 99.99	0.0001		1
75C5 - 75C5	30150 - 30150	var loss due to iron when watts positive	UINT16	0 to 99.99	0.0001		1
75C6 - 75C6	30151 - 30151	var loss due to copper when watts positive	UINT16	0 to 99.99	0.0001		1
75C7 - 75C3	30152 - 30152	watts loss due to iron when watts negative	UINT16	0 to 99.99	0.0001		1
75C8 - 75C48	30153 - 30153	watts loss due to copper when watts negative	UINT16	0 to 99.99	0.0001		1
75C9 - 75C9	30154 - 30154	var loss due to iron when watts negative	UINT16	0 to 99.99	0.0001		1
75CA - 75CA	30155 - 30155	var loss due to copper when watts negative	UINT16	0 to 99.99	0.0001		1
75CB - 75CB	30156 - 30156	transformer loss compensation user settings flag	UINT16	bit-mapped	-------- ----cfwv	c - 0 disable compensation for losses due to copper, 1 enable compensaion for losses due to copper f - 0 disable compensation for losses due to iron, 1 enable compensaion for losses due to iron w - 0 add watt compensation, 1 subtract watt compensation v - 0 add var compensation, 1 subtract var compensation	1
75CC - 75E5	30157 - 30182	Reserved				Reserved	26
75E6 - 75E6	30183 - 30183	Programmable Settings Update Counter	UINT16	0-65535		Increments each time programmable settings are changed; occurs when new checksum is calculated.	1
75E7 - 7626	30184 - 30247	Reserved for Software Use				Reserved	64
						Block Size:	248

Log Setups Block						write only in PS update mode	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
7917 - 7917	31000 - 31000	Historical Log #1 Sizes	UINT16	bit-mapped	eeeeeeee ssssssss	high byte is number of registers to log in each record (0-117), low byte is number of flash sectors for the log (see note 19) 0 in either byte disables the log	1
7918 - 7918	31001 - 31001	Historical Log #1 Interval	UINT16	bit-mapped	00000000 hgfedcba	only 1 bit set: a=1 min, b=3 min, c=5 min, d=10 min, e=15 min, f=30 min, g=60 min, h=EOI pulse	1
7919 - 7919	31002 - 31002	Historical Log #1, Register #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see note 7)	1
791A - 798D	31003 - 31118	Historical Log #1, Register #2 - #117 Identifiers	UINT16	0 to 65535		same as Register #1 Identifier	116
798E - 79D6	31119 - 31191	Historical Log #1 Software Buffer				Reserved for software use.	73
79D7 - 7A96	31192 - 31383	Historical Log #2 Sizes, Interval, Registers & Software Buffer	same as Historical Log #1				192
7A97 - 7B56	31384 - 31575	Historical Log #3 Sizes, Interval, Registers & Software Buffer	same as Historical Log #1				192
7B57 - 7B76	31576 - 31607	Reserved				Reserved	31
						Block Size:	608
7CFF - 7F3E	32000 - 32575	Reserved					576
80E7 - 8326	33000 - 33064	Reserved					576

12-Bit Readings Section

12-Bit Block						read-only except as noted	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
9C40 - 9C40	40001 - 40001	System Sanity Indicator	UINT16	0 or 1	none	0 indicates proper meter operation	1
9C41 - 9C41	40002 - 40002	Volts A-N	UINT16	2047 to 4095	volts	2047= 0, 4095= +150	1
9C42 - 9C42	40003 - 40003	Volts B-N	UINT16	2047 to 4095	volts	volts = 150 * (register - 2047) / 2047	1
9C43 - 9C43	40004 - 40004	Volts C-N	UINT16	2047 to 4095	volts		1
9C44 - 9C44	40005 - 40005	Amps A	UINT16	0 to 4095	amps	0= -10, 2047= 0, 4095= +10	1
9C45 - 9C45	40006 - 40006	Amps B	UINT16	0 to 4095	amps	amps = 10 * (register - 2047) / 2047	1
9C46 - 9C46	40007 - 40007	Amps C	UINT16	0 to 4095	amps		1
9C47 - 9C47	40008 - 40008	Watts, 3-Ph total	UINT16	0 to 4095	watts	0= -3000, 2047= 0, 4095= +3000	1
9C48 - 9C48	40009 - 40009	VARs, 3-Ph total	UINT16	0 to 4095	VARs	watts, VARs, VAs =	1
9C49 - 9C49	40010 - 40010	VAs, 3-Ph total	UINT16	2047 to 4095	VAs	3000 * (register - 2047) / 2047	1
9C4A - 9C4A	40011 - 40011	Power Factor, 3-Ph total	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1 pf = (register - 2047) / 1000	1
9C4B - 9C4B	40012 - 40012	Frequency	UINT16	0 to 2730	Hz	0= 45 or less, 2047= 60, 2730= 65 or more freq = 45 + ((register / 4095) * 30)	1
9C4C - 9C4C	40013 - 40013	Volts A-B	UINT16	2047 to 4095	volts	2047= 0, 4095= +300	1
9C4D - 9C4D	40014 - 40014	Volts B-C	UINT16	2047 to 4095	volts	volts = 300 * (register - 2047) / 2047	1
9C4E - 9C4E	40015 - 40015	Volts C-A	UINT16	2047 to 4095	volts		1
9C4F - 9C4F	40016 - 40016	CT numerator	UINT16	1 to 9999	none	CT = numerator * multiplier / denominator	1
9C50 - 9C50	40017 - 40017	CT multiplier	UINT16	1, 10, 100	none		1
9C51 - 9C51	40018 - 40018	CT denominator	UINT16	1 or 5	none		1
9C52 - 9C52	40019 - 40019	PT numerator	UINT16	1 to 9999	none	PT = numerator * multiplier / denominator	1
9C53 - 9C53	40020 - 40020	PT multiplier	UINT16	1, 10, 100, 1000	none		1
9C54 - 9C54	40021 - 40021	PT denominator	UINT16	1 to 9999	none		1
9C55 - 9C56	40022 - 40023	W-hours, Positive	UINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
9C57 - 9C58	40024 - 40025	W-hours, Negative	UINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2
9C59 - 9C5A	40026 - 40027	VAR-hours, Positive	UINT32	0 to 99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
9C5B - 9C5C	40028 - 40029	VAR-hours, Negative	UINT32	0 to 99999999	VARh per energy format		2
9C5D - 9C5E	40030 - 40031	VA-hours	UINT32	0 to 99999999	VAh per energy format	* see note 10	2
9C5F - 9C60	40032 - 40033	W-hours, Positive, Phase A	UINT32	0 to 99999999	Wh per energy format		2
9C61 - 9C62	40034 - 40035	W-hours, Positive, Phase B	UINT32	0 to 99999999	Wh per energy format		2
9C63 - 9C64	40036 - 40037	W-hours, Positive, Phase C	UINT32	0 to 99999999	Wh per energy format		2
9C65 - 9C66	40038 - 40039	W-hours, Negative, Phase A	UINT32	0 to 99999999	Wh per energy format		2
9C67 - 9C68	40040 - 40041	W-hours, Negative, Phase B	UINT32	0 to 99999999	Wh per energy format		2
9C69 - 9C6A	40042 - 40043	W-hours, Negative, Phase C	UINT32	0 to 99999999	Wh per energy format		2
9C6B - 9C6C	40044 - 40045	VAR-hours, Positive, Phase A	UINT32	0 to 99999999	VARh per energy format		2
9C6D - 9C6E	40046 - 40047	VAR-hours, Positive, Phase B	UINT32	0 to 99999999	VARh per energy format		2
9C6F - 9C70	40048 - 40049	VAR-hours, Positive, Phase C	UINT32	0 to 99999999	VARh per energy format		2
9C71 - 9C72	40050 - 40051	VAR-hours, Negative, Phase A	UINT32	0 to 99999999	VARh per energy format		2
9C73 - 9C74	40052 - 40053	VAR-hours, Negative, Phase B	UINT32	0 to 99999999	VARh per energy format		2
9C75 - 9C76	40054 - 40055	VAR-hours, Negative, Phase C	UINT32	0 to 99999999	VARh per energy format		2
9C77 - 9C78	40056 - 40057	VA-hours, Phase A	UINT32	0 to 99999999	VAh per energy format		2
9C79 - 9C7A	40058 - 40059	VA-hours, Phase B	UINT32	0 to 99999999	VAh per energy format		2
9C7B - 9C7C	40060 - 40061	VA-hours, Phase C	UINT32	0 to 99999999	VAh per energy format		2
9C7D - 9C7D	40062 - 40062	Watts, Phase A	UINT16	0 to 4095	watts		1
9C7E - 9C7E	40063 - 40063	Watts, Phase B	UINT16	0 to 4095	watts		1
9C7F - 9C7F	40064 - 40064	Watts, Phase C	UINT16	0 to 4095	watts		1
9C80 - 9C80	40065 - 40065	VARs, Phase A	UINT16	0 to 4095	VARs	0= -3000, 2047= 0, 4095= +3000	1
9C81 - 9C81	40066 - 40066	VARs, Phase B	UINT16	0 to 4095	VARs	watts, VARs, VAs =	1
9C82 - 9C82	40067 - 40067	VARs, Phase C	UINT16	0 to 4095	VARs	3000 * (register - 2047) / 2047	1
9C83 - 9C83	40068 - 40068	VAs, Phase A	UINT16	2047 to 4095	VAs		1
9C84 - 9C84	40069 - 40069	VAs, Phase B	UINT16	2047 to 4095	VAs		1
9C85 - 9C85	40070 - 40070	VAs, Phase C	UINT16	2047 to 4095	VAs		1
9C86 - 9C86	40071 - 40071	Power Factor, Phase A	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1 pf = (register - 2047) / 1000	1
9C87 - 9C87	40072 - 40072	Power Factor, Phase B	UINT16	1047 to 3047	none		1
9C88 - 9C88	40073 - 40073	Power Factor, Phase C	UINT16	1047 to 3047	none		1
9C89 - 9CA2	40074 - 40099	Reserved	N/A	N/A	none	Reserved	26
9CA3 - 9CA3	40100 - 40100	Reset Energy Accumulators	UINT16	password (Note 5)		write-only register; always reads as 0	1
						Block Size:	100

Log Retrieval Section

Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
Log Retrieval Block						**read/write except as noted**	
C34C - C34D	49997 - 49998	Log Retrieval Session Duration	UINT32	0 to 4294967294	4 msec	0 if no session active; wraps around after max count	2
C34E - C34E	49999 - 49999	Log Retrieval Session Com Port	UINT16	0 to 4		0 if no session active, 1-4 for session active on COM1 - COM4	1
C34F - C34F	50000 - 50000	Log Number, Enable, Scope	UINT16	bit-mapped	nnnnnnnn esssssss	high byte is the log number (0-system, 1-alarm, 2-history1, 3-history2, 4-history3, 5-I/O changes, 11-waveform, (11 reserved for future use) e is retrieval session enable(1) or disable(0) sssssss is what to retrieve (0-normal record, 1-timestamps only, 2-complete memory image (no data validation if image)	1
C350 - C350	50001 - 50001	Records per Window or Batch, Record Scope Selector, Number of Repeats	UINT16	bit-mapped	wwwwwwww snnnnnnn	high byte is records per window if s=0 or records per batch if s=1, low byte is number of repeats for function 35 or 0 to suppress auto-incrementing; max number of repeats is 8 (RTU) or 4 (ASCII) total windows, a batch is all the windows	1
C351 - C352	50002 - 50003	Offset of First Record in Window	UINT32	bit-mapped	ssssssss nnnnnnnn nnnnnnnn nnnnnnnn	ssssssss is window status (0 to 7-window number, 0xFF-not ready); this byte is read-only. nn…nn is a 24-bit record number. The log's first record is latched as a reference point when the session is enabled. This offset is a record index relative to that point. Value provided is the relative index of the whole or partial record that begins the window.	2
C353 - C3CD	50004 - 50126	Log Retrieve Window	UINT16	see comments	none	mapped per record layout and retrieval scope, read-only	123
						Block Size:	130
Log Status Block						**read only**	
Hex	Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg
		Alarm Log Status Block					
C737 - C738	51000 - 51001	Log Size in Records	UINT32	0 to 4,294,967,294	record		2
C739 - C73A	51002 - 51003	Number of Records Used	UINT32	1 to 4,294,967,294	record		2
C73B - C73B	51004 - 51004	Record Size in Bytes	UINT16	14 to 242	byte		1
C73C - C73C	51005 - 51005	Log Availability	UINT16		none	0=available, 1-4=in use by COM1-4, 0xFFFF=not available (log size=0)	1
C73D - C73F	51006 - 51008	Timestamp, First Record	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
C740 - C742	51009 - 51011	Timestamp, Last Record	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3
C743 - C746	51012 - 51015	Reserved				Reserved	4
						Individual Log Status Block Size:	16
C747 - C756	51016 - 51031	System Log Status Block		same as alarm log status block			16
C757 - C766	51032 - 51047	Historical Log 1 Status Block		same as alarm log status block			16
C767 - C776	51048 - 51063	Historical Log 2 Status Block		same as alarm log status block			16
C777 - C786	51064 - 51079	Historical Log 3 Status Block		same as alarm log status block			16
C787 - C796	51080 - 51095	Reserved					16
C797 - C7B6	51096 - 51127	Reserved					32
						Block Size:	128

End of Map

Data Formats	
ASCII	ASCII characters packed 2 per register in high, low order and without any termination characters.
SINT16 / UINT16	16-bit signed / unsigned integer.
SINT32 / UINT32	32-bit signed / unsigned integer spanning 2 registers. The lower-addressed register is the high order half.
FLOAT	32-bit IEEE floating point number spanning 2 registers. The lower-addressed register is the high order half (i.e., contains the exponent).
TSTAM	3 adjacent registers, 2 bytes each. First (lowest-addressed) register high byte is year (0-99), low byte is month (1-12). Middle register high byte is day(1-31), low byte is hour (0-23 plus DST bit).
P	DST (daylight saving time) bit is bit 6 (0x40). Third register high byte is minutes (0-59), low byte is seconds (0-59). For example, 9:35:07AM on October 12, 2049 would be 0x310A, 0x0C49, 0x2307, assuming DST is in effect.

Notes	
1	All registers not explicitly listed in the table read as 0. Writes to these registers will be accepted but won't actually change the register (since it doesn't exist).
2	Meter Data Section items read as 0 until first readings are available or if the meter is not in operating mode. Writes to these registers will be accepted but won't actually change the register.
3	Register valid only in programmable settings update mode. In other modes these registers read as 0 and return an illegal data address exception if a write is attempted.
4	Meter command registers always read as 0. They may be written only when the meter is in a suitable mode. The registers return an illegal data address exception if a write is attempted in an incorrect mode.
5	If the password is incorrect, a valid response is returned but the command is not executed. Use 5555 for the password if passwords are disabled in the programmable settings.
6	M denotes a 1,000,000 multiplier.
7	Each identifier is a Modbus register. For entities that occupy multiple registers (FLOAT, SINT32, etc.) all registers making up the entity must be listed, in ascending order. For example, to log phase A volts, VAs, and VA hours, the register list would be 0x3E7, 0x3E8, 0x411, 0x412, 0x61D, 0x61E and the number of registers (0x7917 high byte) would be 7.
8	Writing this register causes data to be saved permanently in nonvolatile memory. Reply to the command indicates that it was accepted but not whether or not the save was successful. This can only be determined after the meter has restarted.
9	Reset commands make no sense if the meter state is LIMP. An illegal function exception will be returned.
10	Energy registers should be reset after a format change.
11	Entities to be monitored against limits are identified by Modbus address. Entities occupying multiple Modbus registers, such as floating point values, are identified by the lower register address. If any of the 8 limits is unused, set its identifier to zero. If the indicated Modbus register is not used or is a nonsensical entity for limits, it will behave as an unused limit.
12	There are 2 setpoints per limit, one above and one below the expected range of values. LM1 is the "too high" limit, LM2 is "too low". The entity goes "out of limit" on LM1 when its value is greater than the setpoint. It remains "out of limit" until the value drops below the in threshold. LM2 works similarly, in the opposite direction. If limits in only one direction are of interest, set the in threshold on the "wrong" side of the setpoint. Limits are specified as % of full scale, where full scale is automatically set appropriately for the entity being monitored: current FS = CT numerator * CT multiplier voltage FS = PT numerator * PT multiplier 3 phase power FS = CT numerator * CT multiplier * PT numerator * PT multiplier * 3 [* SQRT(3) for delta hookup] single phase FS = CT numerator * CT multiplier * PT numerator * PT multiplier [* SQRT(3) for delta hookup] frequency FS = 60 (or 50) power factor FS = 1.0 percentage FS = 100.0 angle FS = 180.0
13	n/a
14	n/a
15	A block of data and control registers is allocated for each option slot. Interpretation of the register data depends on what card is in the slot.
16	Measurement states: Off occurs during programmable settings updates; Run is the normal measuring state; Limp indicates that an essentail non-volatile memory block is corrupted; and Warmup occurs briefly (approximately 4 seconds) at startup while the readings stabilize. Run state is required for measurement, historical logging, demand interval processing, limit alarm evaluation, and min/max comparisonss. Resetting min/max or energy is allowed only in run and off states; warmup will return a busy exception. In limp state, the meter reboots at 5 minute intervals in an effort to clear the problem.
17	Limits evaluation for all entites except demand averages commences immediately after the warmup period. Evaluation for demand averages, maximum demands, and minimum demands commences at the end of the first demand interval after startup.
18	n/a
19	There are 15, 29, or 45 flash sectors available in a common pool for distribution among the 3 historical logs. The pool size, number of sectors for each log, and the number of registers per record together determine the maximum number of records a log can hold. S = number of sectors assigned to the log,
20	n/a
21	Logs cannot be reset during log retrieval. Busy exception will be returned.

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C: DNP Mapping

C.1: Overview

This Appendix describes the functionality of the Shark® 200S meter's version of the DNP protocol. A DNP programmer needs this information to retrieve data from the Shark® 200S meter. The DNP version used by the Shark 200S is a reduced set of the Distributed Network Protocol Version 3.0 subset 2; it gives enough functionality to get critical measurements from the Shark® 200S meter.

The Shark® 200S meter's DNP version supports Class 0 object/qualifiers 0,1,2,6, only. No event generation is supported. The Shark® 200S meter always acts as a secondary device (slave) in DNP communication.

A new feature allows DNP readings in primary units with user-set scaling for current, Voltage, and power (see Chapter 5 in the *Communicator EXT User Manual* for instructions).

C.2: Physical Layer

The Shark® 200S meter's DNP version uses serial communication. Port 2 (RS485 compliant port) or any communication capable option board can be used. Speed and data format is transparent for the Shark® 200S meter's DNP version: they can be set to any supported value. The IrDA port cannot use DNP.

C.3: Data Link Layer

The Shark® 200S meter can be assigned a value from 1 to 65534 as the target device address. The data link layer follows the standard frame FT3 used by DNP Version 3.0 protocol, but only 4 functions are implemented: Reset Link, Reset User, Unconfirmed User Data, and Link Status, as depicted in the following table.

Function	Function Code
Reset Link	0
Reset User	1
Unconfirmed User Data	4
Link Status	9

Table C.1: Supported Link Functions

[dst] and [src] are the device address of the Shark® 200S meter and Master device, respectively. Refer to Section C.7 for more detail on supported frames for the data link layer.

In order to establish optimal communication with the Shark® 200S meter, we recommend that you perform the Reset Link and Reset User functions. The Link Status is not mandatory, but can be performed as well. The inter-character time-out for DNP is 1 second. If this amount of time, or more, elapses between two consecutive characters within a FT3 frame, the frame will be dropped.

C.4: Application Layer

The Shark® 200S meter's DNP version supports the Read, Write, Direct Operate and Direct Operate Unconfirmed functions.

- The Read function (code 01) provides a means for reading the critical measurement data from the meter. This function should be posted to read object 60 variation 1, which will read all the available Class 0 objects from the DNP register map. See the register map in Section C.6. In order to retrieve all objects with their respective variations, the qualifier must be set to ALL (0x06). See Section C.7 for an example showing a read Class 0 request data from the meter.

- The Write function (code 02) provides a means for clearing the Device restart bit in the Internal Indicator register only. This is mapped to Object 80, point 0 with variation 1. When clearing the restart device indicator use qualifier 0. Section C.7 shows the supported frames for this function.

- The Direct Operate function (code 05) is intended for resetting the energy counters and the Demand counters (minimum and maximum energy registers). These actions are mapped to Object 12, points 0 and 2, which act as control relays. The relays must be operated (On) in 0 msec and released (Off) in 1 msec only. Qualifiers 0x17 or x28 are supported for writing the energy reset. Sample frames are shown in Section C.7.

- The Direct Operate Unconfirmed (or Unacknowledged) function (code 06) is intended for asking the communication port to switch to Modbus RTU protocol from DNP. This switching acts as a control relay mapped into Object 12, point 1 in the meter. The relay must be operated with qualifier 0x17, code 3 count 0, with 0 milliseconds on and 1 millisecond off, only. After sending this request the current

communication port will accept Modbus RTU frames only. To make this port go back to DNP protocol, the unit must be powered down and up. Section C.7 shows the constructed frame to perform DNP to Modbus RTU protocol change.

C.5: Error Reply

In the case of an unsupported function, or any other recognizable error, an error reply is generated from the Shark® 200S meter to the Primary station (the requester). The Internal Indicator field will report the type of error: unsupported function or bad parameter.

The broadcast acknowledge and restart bit are also signaled in the Internal Indicator field, but they do not indicate an error condition.

C.6: Shark® 200S Meter's DNP Register Map

Object 10 - Binary Output States

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
10	0	2	Reset Energy Counters	BYTE	Always 1	N/A	None	Read by Class 0 or with qualifier 0, 1, 2, or 6
10	1	2	Change to Modbus RTU Protocol	BYTE	Always 1	N/A	None	Read by Class 0 or with qualifier 0, 1, 2, or 6
10	2	2	Reset Demand Cntrs (Max / Min)	BYTE	Always 1	N/A	None	Read by Class 0 or with qualifier 0, 1, 2, or 6

Object 12 - Control Relay Outputs

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
12	0	1	Reset Energy Counters	N/A	N/A	N/A	none	Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY.
12	1	1	Change to Modbus RTU Protocol	N/A	N/A	N/A	none	Responds to Function 6 (Direct Operate - No Ack), Qualifier Code 17x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY.

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
12	2	1	Reset Demand Counters (Max / Min)	N/A	N/A	N/A	none	Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY.

Object 20 - Binary Counters (Primary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
20	0	5	W-hours, Positive	UINT32	0 to 99999999	Multiplier = 10(n-d), where n and d are derived from the energy format. n = 0, 3, or 6 per energy format scale and d = number of decimal places.	Whr	example: energy format = 7.2K and W-hours counter = 1234567 n=3 (K scale), d=2 (2 digits after decimal point), multiplier = 10(3-2) = 101 = 10, so energy is 1234567 * 10 Whrs, or 12345.67 KWhrs
20	1	5	W-hours, Negative	UINT32	0 to 99999999		Whr	
20	2	5	VAR-hours, Positive	UINT32	0 to 99999999		VARhr	
20	3	5	VAR-hours, Negative	UINT32	0 to 99999999		VARhr	
20	4	5	VA-hours, Total	UINT32	0 to 99999999		VAhr	

Object 30 - Analog Inputs (Secondary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	0	4	Meter Health	sint16	0 or 1	N/A	None	0 = OK
30	1	4	Volts A-N	sint16	0 to 32767	(150 / 32768)	V	Values above 150V secondary read 32767.
30	2	4	Volts B-N	sint16	0 to 32767	(150 / 32768)	V	
30	3	4	Volts C-N	sint16	0 to 32767	(150 / 32768)	V	

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	4	4	Volts A-B	sint16	0 to 32767	(300 / 32768)	V	Values above 300V secondary read 32767.
30	5	4	Volts B-C	sint16	0 to 32767	(300 / 32768)	V	
30	6	4	Volts C-A	sint16	0 to 32767	(300 / 32768)	V	
30	7	4	Amps A	sint16	0 to 32767	(10 / 32768)	A	Values above 10A secondary read 32767.
30	8	4	Amps B	sint16	0 to 32767	(10 / 32768)	A	
30	9	4	Amps C	sint16	0 to 32767	(10 / 32768)	A	
30	10	4	Watts, 3-Ph total	sint16	-32768 to +32767	(4500 / 32768)	W	
30	11	4	VARs, 3-Ph total	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	12	4	VAs, 3-Ph total	sint16	0 to +32767	(4500 / 32768)	VA	
30	13	4	Power Factor, 3-Ph total	sint16	-1000 to +1000	0.001	None	
30	14	4	Frequency	sint16	0 to 9999	0.01	Hz	
30	15	4	Positive Watts, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	W	
30	16	4	Positive VARs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	17	4	Negative Watts, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	W	
30	18	4	Negative VARs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	19	4	VAs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VA	
30	20	4	Angle, Phase A Current	sint16	-1800 to +1800	0.1	degree	
30	21	4	Angle, Phase B Current	sint16	-1800 to +1800	0.1	degree	
30	22	4	Angle, Phase C Current	sint16	-1800 to +1800	0.1	degree	

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	23	4	Angle, Volts A-B	sint16	-1800 to +1800	0.1	degree	
30	24	4	Angle, Volts B-C	sint16	-1800 to +1800	0.1	degree	
30	25	4	Angle, Volts C-A	sint16	-1800 to +1800	0.1	degree	
30	26	4	CT numerator	sint16	1 to 9999	N/A	none	CT ratio = (numerator * multiplier) / denominator
30	27	4	CT multiplier	sint16	1, 10, or 100	N/A	none	
30	28	4	CT denominator	sint16	1 or 5	N/A	none	
30	29	4	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio = (numerator * multiplier) / denominator
30	30	4	PT multiplier	SINT16	1, 10, or 100	N/A	none	
30	31	4	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	4	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767

Object 80 - Internal Indicator

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
80	7	1	Device Restart Bit	N/A	N/A	N/A	none	Clear via Function 2 (Write), Qualifier Code 0.

C.7: DNP Message Layouts

Legend

All numbers are in hexadecimal base. In addition the following symbols are used.

dst	16 bit frame destination address
src	16 bit frame source address
crc	DNP Cyclic redundant checksum (polynomial $x^{16}+x^{13}+x^{12}+x^{11}+x^{10}+x^7+x^6+x^5+x^2+1$)
x	transport layer data sequence number
y	application layer data sequence number

Link Layer related frames

Reset Link

Request	05	64	05	C0	dst	src	crc
Reply	05	64	05	00	src	dst	crc

Reset User

Request	05	64	05	C1	dst	src	crc
Reply	05	64	05	00	src	dst	crc

Link Status

Request	05	64	05	C9	dst	src	crc
Reply	05	64	05	0B	src	dst	crc

Application Layer related frames

Clear Restart

Request	05	64	0E	C4	dst	src	crc			
	Cx	Cy	02	50	01	00	07	07	00	crc
Reply	05	64	0A	44	src	dst	crc			
	Cx	Cy	81	int. ind.	crc					

Class 0 Data

Request	05	64	0B	C4	dst	src	crc									
	Cx	Cy	01	3C	01	06	crc									
Request (alternate)	05	64	14	C4	dst	src	crc									
	Cx	Cy	01	3C	02	06	3C	03	06	3C	04	06	3C	01	06	crc
Reply (same for either request)	05	64	72	44	src	dst	crc									
	Cx	Cy	81	int. ind.	14	05	00	00	04	pt 0	pt 1	crc				
	pt 1	pt 2	pt 3	pt 4	1E	04	crc									
	00	00	20	pt 0	pt 1	pt 2	pt 3	pt 4	pt 5	pt6	crc					
	pt6	pt 7	pt 8	pt 9	pt 10	pt 11	pt 12	pt 13		crc						
		pt 15	pt 16	pt 17	pt 18	pt 19	pt 20	pt 21		crc						
		pt 23	pt 24	pt 25	pt 26	pt 27	pt 28	pt 29		crc						
		pt 31	pt 32	0A	02	00	00	02	pt0	pt1	pt2	crc				

Reset Energy

Request	05	64	18	C4	dst		src		crc									
	Cx	Cy	05	0C	01	17	01	00	03	00	00	00	00	00	01	00	crc	
	00	00	00	crc														
Reply	05	64	1A	44	src		dst		crc									
	Cx	Cy	81	int. ind.		0C	01	17	01	00	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc												

Request (alternate)	05	64	1A	C4	dst		src		crc									
	Cx	Cy	05	0C	01	28	01	00	00	00	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc												
Reply	05	64	1C	44	src		dst		crc									
	Cx	Cy	81	int. ind.		0C	01	28	01	00	00	00	03	00	00	00	crc	
	00	00	01	00	00	00	00	crc										

Switch to Modbus

Request	05	64	18	C4	dst		src		crc									
	Cx	Cy	06	0C	01	17	01	01	03	00	00	00	00	00	01	00	crc	
	00	00	00	crc														
No Reply																		

Reset Demand (Maximums & Minimums)

Request	05	64	18	C4	dst		src		crc									
	Cx	Cy	05	0C	01	17	01	02	03	00	00	00	00	00	01	00	crc	
	00	00	00	crc														
Reply	05	64	1A	44	src		dst		crc									
	Cx	Cy	81	int. ind.		0C	01	17	01	02	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc												

Request (alternate)	05	64	1A	C4	dst		src		crc									
	Cx	Cy	05	0C	01	28	01	02	00	00	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc												
Reply	05	64	1C	44	src		dst		crc									
	Cx	Cy	81	int. ind.		0C	01	28	01	02	00	00	03	00	00	00	crc	
	00	00	01	00	00	00	00	crc										

Error Reply

Reply	05	64	0A	44	src		dst		crc	
	Cx	Cy	81	int. ind.		crc				

C.8: Internal Indication Bits

Bits implemented in the Shark® 200S meter are listed below. All others are always reported as zeroes.

Bad Function

Occurs if the function code in a User Data request is not Read (0x01), Write (0x02), Direct Operate (0x05), or Direct Operate, No Ack (0x06).

Object Unknown

Occurs if an unsupported object is specified for the Read function. Only objects 10, 20, 30, and 60 are supported.

Out of Range

Occurs for most other errors in a request, such as requesting points that don't exist or direct operate requests in unsupported formats.

Buffer Overflow

Occurs if a read request or a read response is too large for its respective buffer. In general, if the request overflows, there will be no data in the response while if the response overflows at least the first object will be returned. The largest acceptable request has a length field of 26, i.e. link header plus 21 bytes more, not counting checksums. The largest possible response has 7 blocks plus the link header.

Restart
All Stations

These 2 bits are reported in accordance with standard practice.

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D: Using the USB to IrDA Adapter (CAB6490)

D.1: Introduction

Com 1 of the Shark® 200S meter is the IrDA port, located on the face of the meter. One way to communicate with the IrDA port is with EIG's USB to IrDA Adapter (CAB6490), which allows you to access the Shark® 200S meter's data from a PC. This Appendix contains instructions for installing the USB to IrDA Adapter.

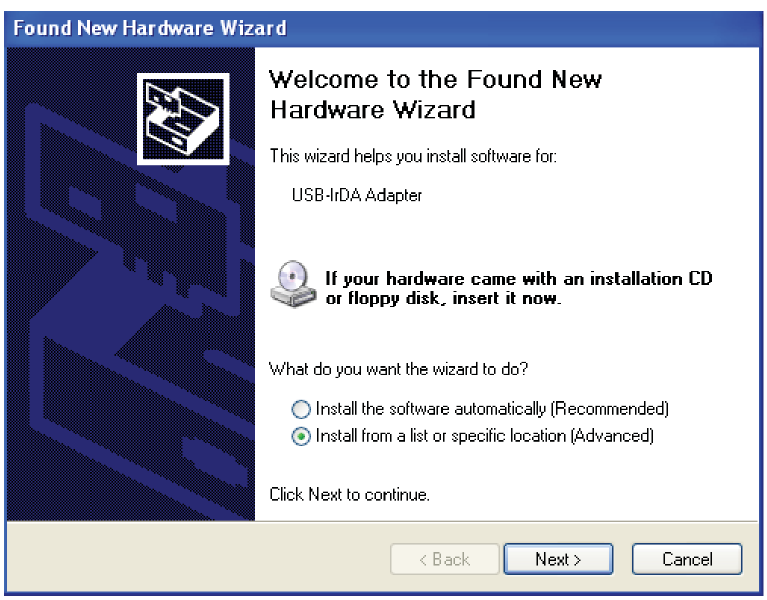
D.2: Installation Procedures

You can order CAB6490 from EIG's webstore: www.electroind.com/store. Select Cables and Accessories from the list on the left side of the screen. The USB to IrDA Adapter comes packaged with a USB cable and an Installation CD. Follow this procedure to install the Adapter on your PC.

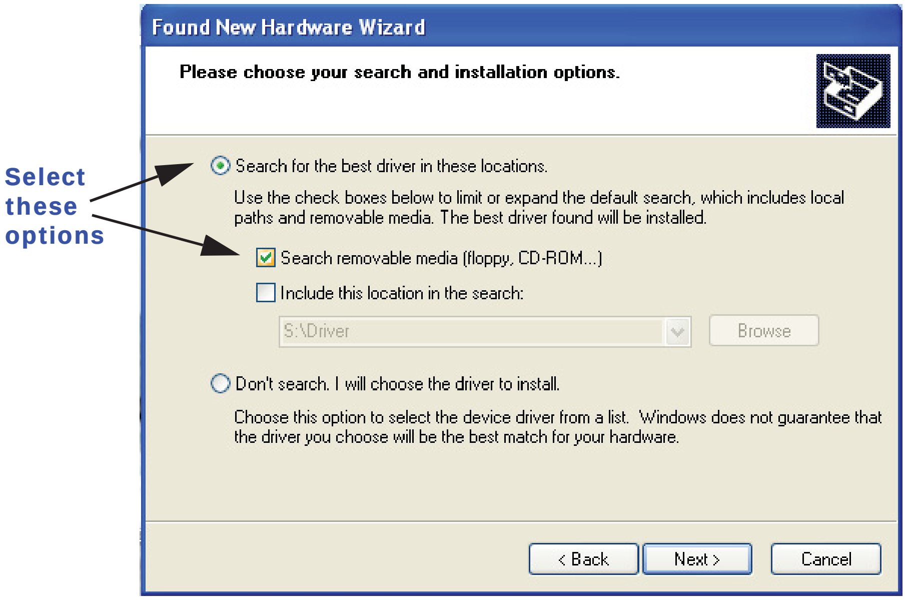
1. Connect the USB cable to the USB to IrDA Adapter, and plug the USB into your PC's USB port.

2. Insert the Installation CD into your PC's CD ROM drive.

3. You will see the screen shown below. The Found New Hardware Wizard allows you to install the software for the Adapter. Click the Radio Button next to **Install from a list or specific location**.

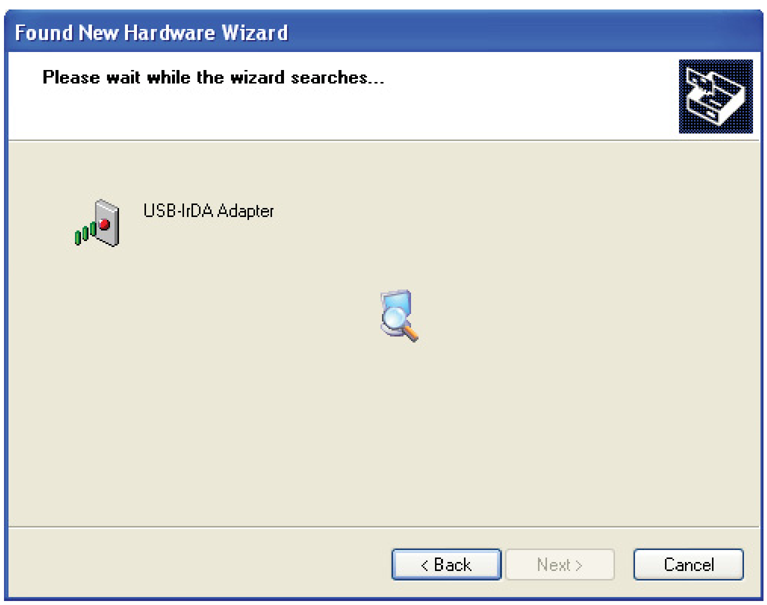


4. Click **Next**. You will see the screen shown on the next page.

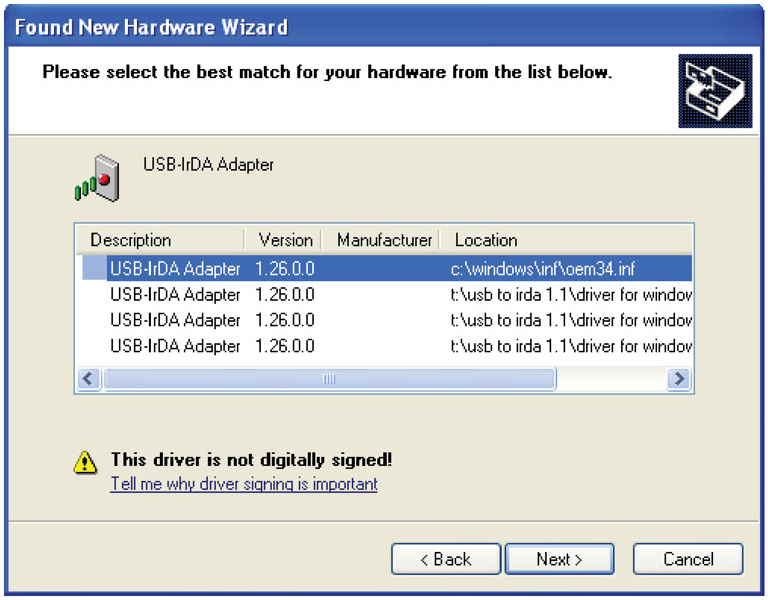


5. Make sure the first Radio Button and the first Checkbox are selected, as shown above. These selections allow the Adapter's driver to be copied from the Installation disk to your PC.

6. Click **Next**. You will see the screen shown below.

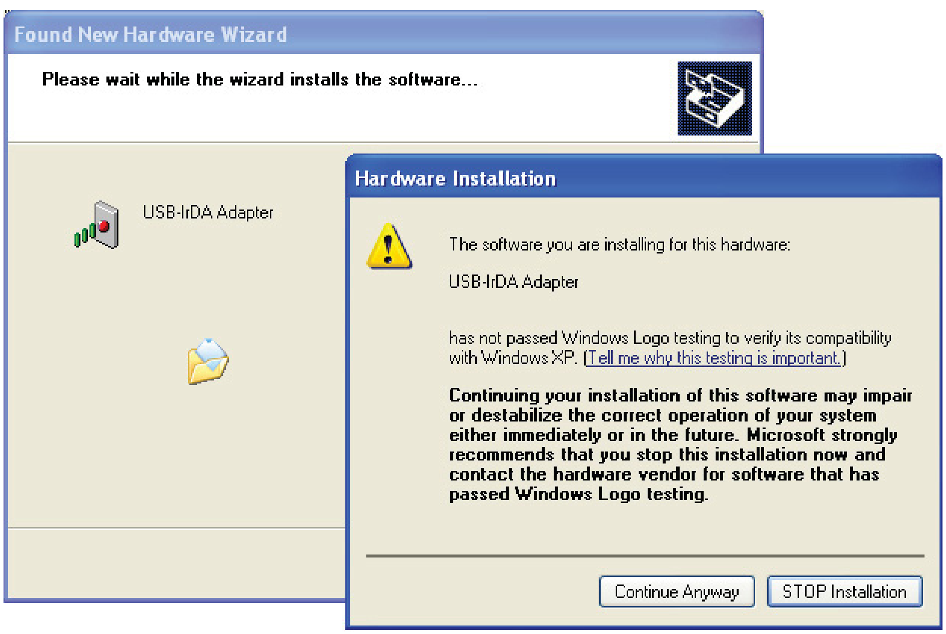


7. When the driver for the Adapter is found, you will see the screen shown on the next page.

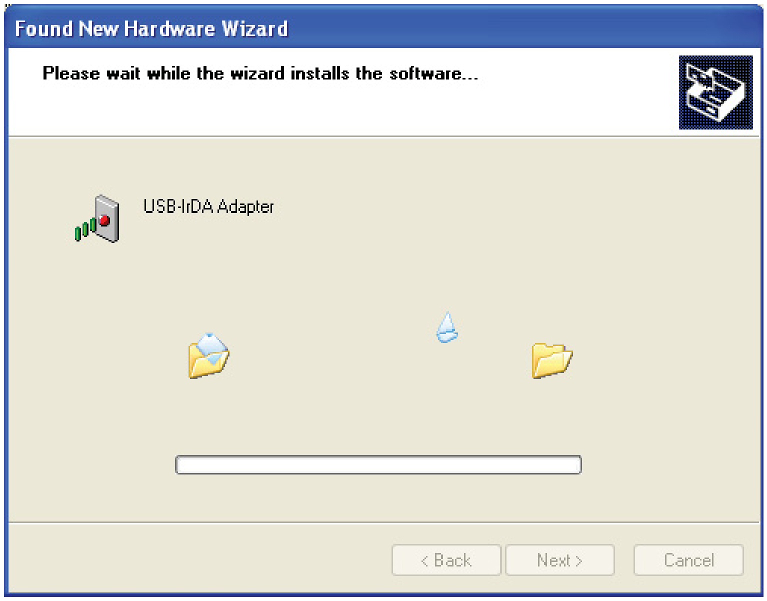


8. You do not need to be concerned about the message on the bottom of the screen. Click **Next** to continue with the installation.

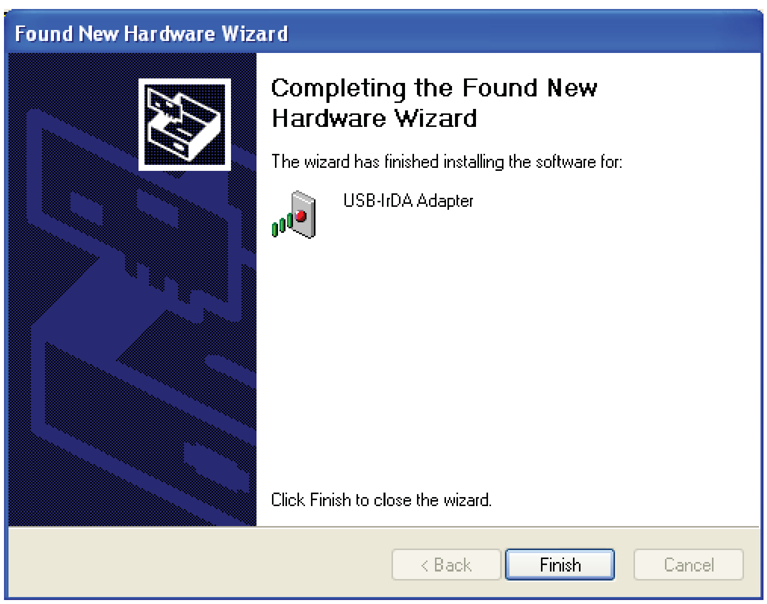
9. You will see the two windows shown below. Click **Continue Anyway.**



10. You will see the screen shown below while the Adapter's driver is being installed on your PC.



11. When driver installation is complete, you will see the screen shown below.



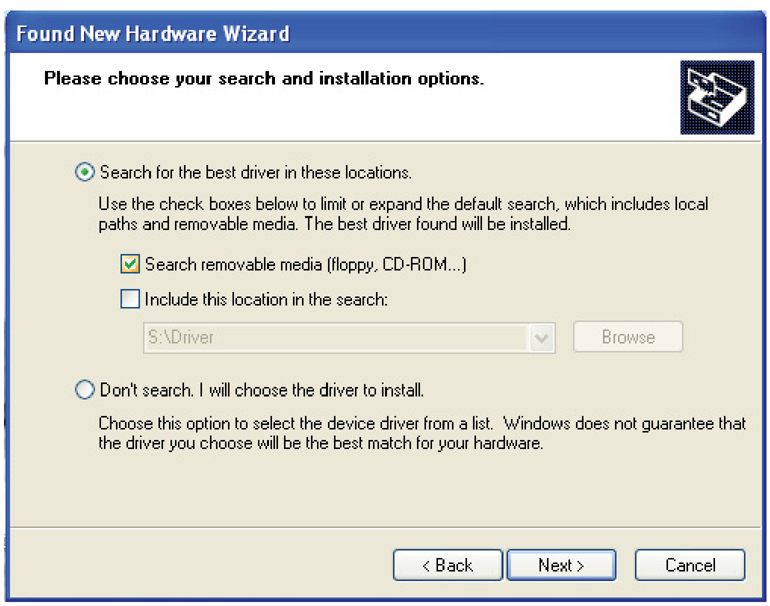
12. Click **Finish** to close the Found New Hardware Wizard.

IMPORTANT! Do NOT remove the Installation CD until the entire procedure has been completed.

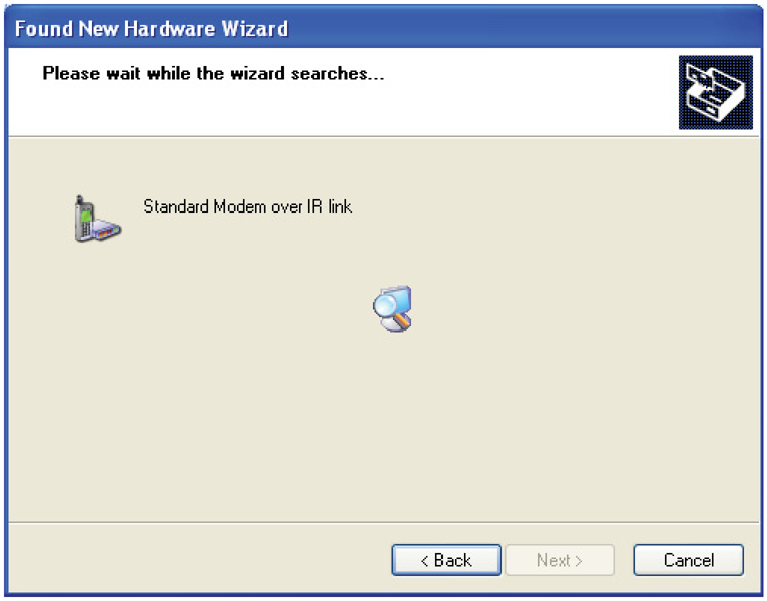
13.Position the USB to IrDA Adapter so that it points directly at the IrDA on the front of the Shark® 200S meter. It should be as close as possible to the meter, and not more than 15 inches/38 cm away from it.

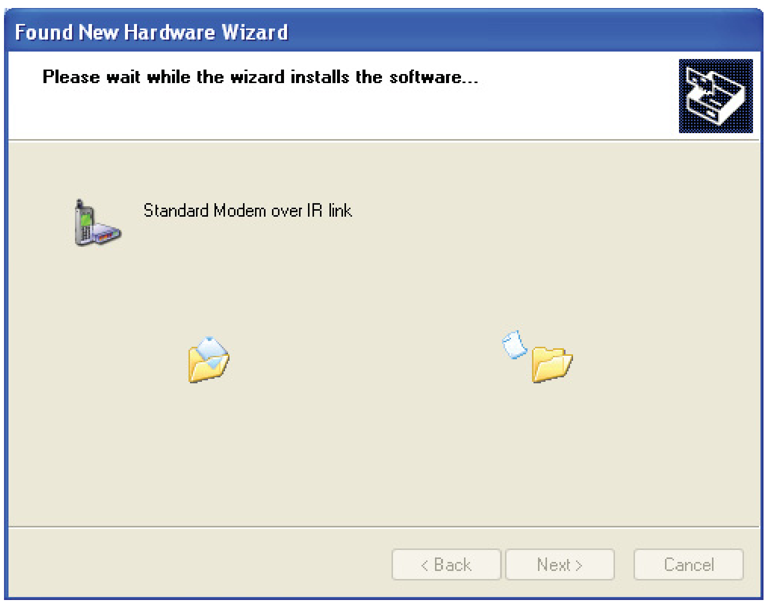
14.The Found New Hardware Wizard screen opens again. This time, click the Radio Button next to Install the software automatically.

15.Click **Next.** You will see the screen shown below.

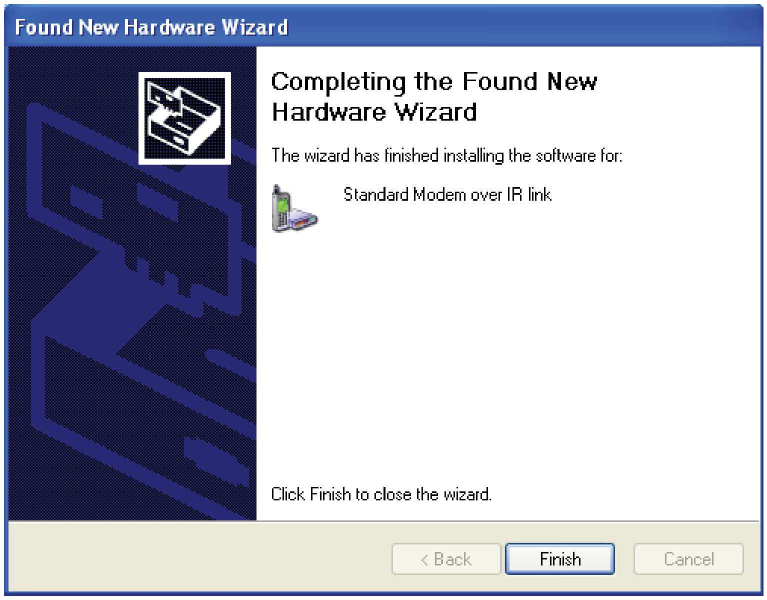


16.Make sure the first Radio Button and the first Checkbox are selected, as shown above screen. Click **Next.** You will see the two screens shown on the next page.


Found New Hardware Wizard
Please wait while the wizard searches...
Standard Modem over IR link
< Back
Next >
Cancel


Found New Hardware Wizard
Please wait while the wizard installs the software...
Standard Modem over IR link
< Back
Next >
Cancel

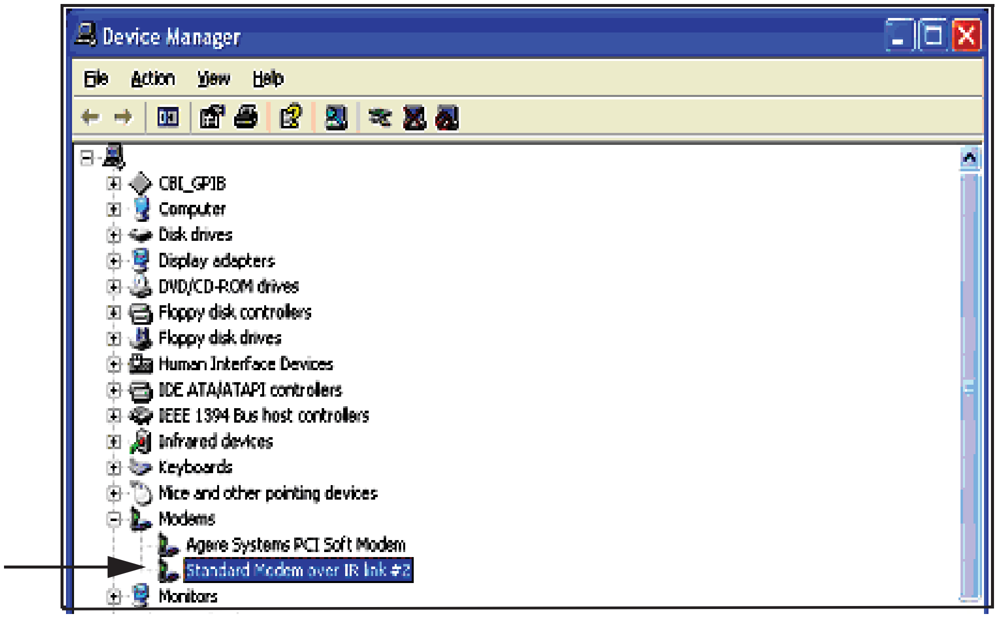
17.When installation is complete, you will see the screen shown below.



18.Click **Finish** to close the Found New Hardware Wizard.

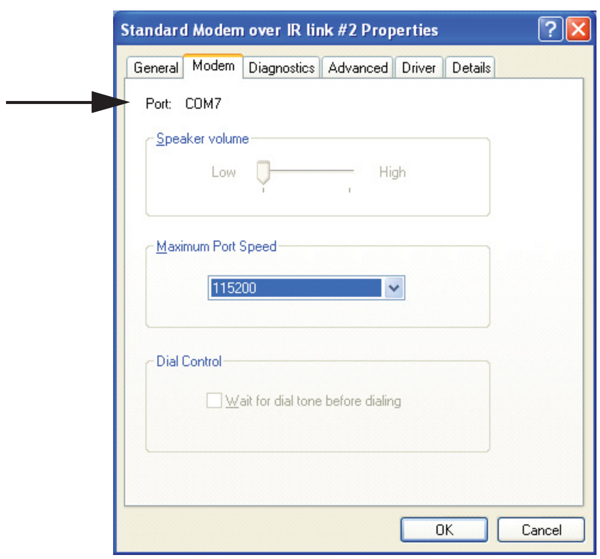
19.To verify that your Adapter has been installed properly, click **Start>Settings>Control Panel>System>Hardware>Device Manager**. The USB to IrDA Adapter should appear under both Infrared Devices and Modems (click on the + sign to display all configured modems). See the example screen on the next page.

NOTE: If the Adapter doesn't show up under Modems, move it away from the meter for a minute and then position it pointing at the IrDA, again.



20.Double-click on the Standard Modem over IR link (this is the USB to IrDA Adapter). You will see the Properties screen for the Adapter.

21.Click the Modem tab. The Com Port that the Adapter is using is displayed in the screen.



22.Use this Com Port to connect to the meter from your PC, using the Communicator EXT software. Refer to Chapter 2 of the *Communicator EXT User Manual* for detailed connection instructions.